

STUDIES IN THE XYLARIACEAE:

V. EUHYPOXYLON

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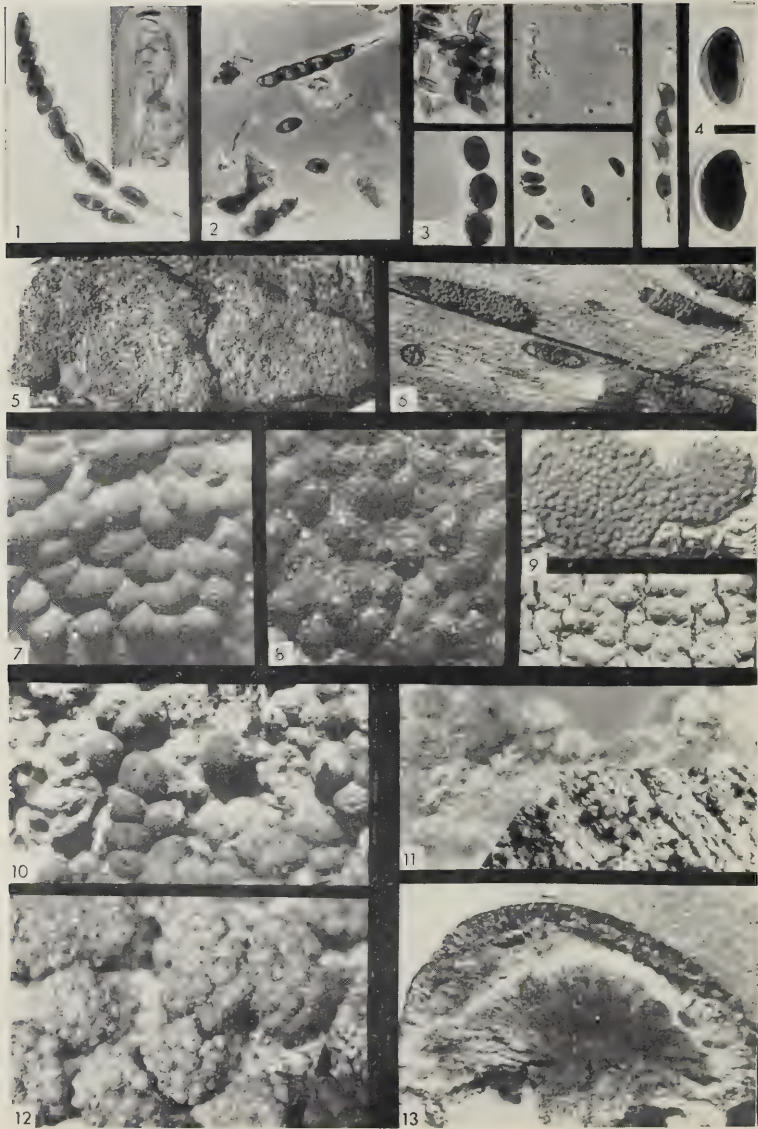
INTRODUCTION

The members of this group are more closely related to each other than are those in the previous groups just discussed and there is also a larger number of them. Thus the classification of the species has been sometimes based on extremely fine characters, resulting in much confusion. Theissen (1909) has suggested that on account of similarities in colouration and stromal morphology one species only should be recognized, though with several varieties. Miller (1933) contested this view, pointing out that different geographical distributions of the various types throughout the world provided strong evidence for speciation. The writer considers that broad differences in superficial colouration and other morphological characters may also be used judiciously to delimit 4 subgroups:

- a) The Oodes series (6 spp.) (p. 155)
Stromata rosellinioid; colouration as in *a*) or *b*).
- b) The Rubiginosum series (9 spp.) (p. 167)
Stromata restricted; surface some shade of grey-brown, red or purple with matching subsurface colouration.
- c) The Hypomiltum series (13 spp.) (p. 184)
As above, but with surface or subsurface bright coloured.
- d) The Fragiforme series (6 spp.) (p. 198)
Stromata massive as in *Daldinia*; colouration as in *b*).

The first and last groups are linked by sporadic development of *Graphium*-type coremia.

Discoid ascal plugs (Plate I:1) and umbilicate ostioles characterize the group as a whole. When the ostioles are raised on perithecial projections they often appear papillate. The latter character undoubtedly led Miller (1961 p. 46) to place *Hypoxylon croceum*, *H. rutilum* and *H. novemexicanum* in the Papillata group. Conversely, his inclusion of *H. sassafras* in Euhypoxylon is also wrong



because its stromal characters as a whole conform to those of *Entoleuca*, in spite of the presence of depressed ostioles. In two further species (*H. oodes*, *H. riograndense*) however, the ostioles may be actually papillate but their other characters conform closest to the *Euhypoxylon* group. (See Plate I: 7-12)

KEY TO THE SPECIES

	Stromata without evident coloration at maturity, either superficially or on microscopic examination; predominantly grey or grey-brown	2
1'	Surface or interior of stromata coloured	3
2	Spores $5.5-6.5 \times 11.5-14.0\mu^*$ Conidiophores in culture <i>Sporothrix</i> I—II: <i>Hypoxylon plumbinum</i> Martin, nov. sp. (p. 167)	
2'	Spores $8.5 \times 27.0\mu$ <i>Hypoxylon macrosporum</i> Karsten (p. 168)	
3 (1)	Surface of stroma deep blue, spores $4.5 \times 8.0\mu$ <i>Hypoxylon aeruginosum</i> Miller	
3'	Surface of stroma olive green, spores $5.0 \times 11.5\mu$ <i>Hypoxylon viridicolor</i> Martin, nov. sp. (p. 187)	
3''	Surface of stroma white superficially, later dull; interior vinaceous or orange	13
3'''	Surface of stroma differently coloured	4

*Figures expressed to the first place of decimals, represent averages of a set of measurements; integers only, the mere range of dimensions.

PLATE I Stromata and spores.

1. Ascus of *Hypoxylon fuscum*, showing discoid apical plugs $\times 210$; inset $\times 540$.
2. *Hypoxylon occidentale*: refractive (vinaceous) ectostromal particles and ascospores in squash mount $\times 210$.
3. Ascospores, $\times 210$: upper left: *Hypoxylon murcidum*
lower left: *Hypoxylon sphaeriosporum*
upper centre: *Hypoxylon dieckmanni*
lower centre: *Hypoxylon albostigmatosum*
right: *Hypoxylon rubiginosum*
4. Detail of ascospores, $\times 540$
upper: *Hypoxylon fuscum*, typical of *Euhypoxylon*
lower: *Hypoxylon rubrostromaticum*, with gelatinous spore sheath
- 5—13 Stromata and associated structures
5. *Hypoxylon novemexicanum*, $\times 2$. White mealy ectostroma
6. *Hypoxylon plumbinum*, $\times 2$. Smooth surface, indistinct ostioles
7. *Hypoxylon murcidum*, $\times 10$. Minute papillate or umbilicate ostioles
8. *Hypoxylon occidentale*, $\times 10$. Granulate surface, indistinct raised ostioles
9. Characteristic umbilicate ostioles in upper, *Hypoxylon ferrugineum* $\times 2$
lower, *Hypoxylon fuscum* $\times 5$
10. *Hypoxylon oodes*, $\times 10$. Loosely coalesced perithecia in all stages of development, some with papillate ostioles
11. *Hypoxylon oodes*. Coremia in side view, $\times 20$.
Inset: surface view of coremia, $\times 10$.
12. *Hypoxylon multiforme* (Papillata group), $\times 5$. Strongly papillate ostioles for comparison with above.
13. *Hypoxylon sclerophaeum*, $\times 5$. Longitudinal section of stroma showing massive basal tissue.

- 4 Ectostromal interior dull, brown, red or red-vinaceous, at sight or in microscopical examination; stromata never massive in construction; spores sometimes with hyaline sheaths 5
- 4' Ectostromal interior brightly coloured, yellow, orange or lateritic, at sight or in microscopical examination; stromata variable, sometimes massive in construction 15
- 5 Stromata erumpent, ostioles usually wide mouthed and periphysate; surface of stroma brown or olivaceous brown, interior dark; spores $5.0-6.5 \times 10.0-12.0\mu$
Conidiophores in culture: *Sporothrix* II:
Hypoxylon ferrugineum (Oth.) Miller (p. 169)
- 5' Stromata superficial, if occasionally erumpent then surface at least partially red 6
- 6 Stromata containing from one to many perithecia evident in outline or loosely coalesced; surface colour variable, red brown to lilac, purple or violaceous 7
- 6' Stromata multiperitheciate or rarely uniperitheciate as well; perithecia with a greater degree of coalescence; surface colour red brown to purple-maroon 8
- 7 Stromata lilac to dull red brown; ostioles umbilicate or occasionally papillate, black and sometimes conspicuous against the rest; *Graphium*-type coremia often present; initial stage dull red; spores dark brown, $4.0-6.5 \times 9.5-12.5\mu$
Conidiophores in culture: *Sporothrix* I—III
Hypoxylon oodes Berk. & Br. (p. 155)
- 7' Stromata reddish brown; ostioles umbilicate or slightly raised, but not conspicuous; conidial stage hyphomycetous, initial stage bright coloured, varying from salmon pink to yellow brown; spores usually dark, $4.0-5.5 \times 9.5-11.0\mu$
Conidiophores in culture: *Sporothrix* IV—V
Hypoxylon croceum Miller (p. 159)
- 7'' Stromata purple red or violaceous, ostioles umbilicate or slightly raised but not conspicuous; conidial stage hyphomycetous, initial stage dull red, spores amber to pale brown, $3.5-5.5 \times 7.0-13.0\mu$
Conidiophores in culture: *Sporothrix* IV—V
Hypoxylon riograndense Rehm (p. 161)
- 8 (6) Spores usually amber or pale brown, if dark then narrow navicular; perithecia adjacent to close crowded, rarely compacted, sometimes developing individually within a common stromal matrix; ostioles sometimes papillate 9
- 8' Spores medium or dark brown, fairly broad, if lighter then perithecia compact; perithecia normally closely associated and not usually separate, ostioles never papillate 10
- 9 Stromata purple-red or violaceous, ostioles umbilicate, slightly raised but not conspicuous; initial stage dull red, spores $3.5-5.5 \times 7.0-13.0\mu$
Conidiophores in culture: *Sporothrix* IV—V
Hypoxylon riograndense Rehm (p. 161)
- 9' Stromata deep purple-red, ostioles poroid umbilicate or minutely papillate; initial stage bright yellow; spores $5.0-5.5 \times 11.0-12.5\mu$
Conidiophores in culture: *Sporothrix* I—II
Hypoxylon murcidum Berk. & Br. (p. 163)
- 10 (8) Spores oval to subglobose, at least one half as wide as long, equilateral, $5.5 \times 9.5-10.5 \times 17.0\mu$, dark brown to black; stroma pulvinate to applanate with red purple surface.
Hypoxylon sphaeriosporum Martin nov. sp. (p. 176)
- 10' Not with this character combination, spores not subglobose 11

- 11 Stromata deep purple red, crustose, fairly effuse, ostioles indistinct, perithecia compact; spores pale to dark brown, $3.5-4.5 \times 7.5-9.0\mu$
Conidiophores in culture: *Sporothrix* IV
Hypoxylon dieckmanni Theissen (p. 170)
- 11' Stromata purple-brown to purple-red, not usually effused, often with white periphysate ostiolar mouths; spores pale to medium brown, subhyaline or opaque, $4.5-6.0 \times 9.5-12.0\mu$
Conidiophores in culture: *Sporothrix* I—II
Hypoxylon rubiginosum Pers. ex Fr. (p. 172)
- 11'' Stromata pale purple-red to purple-grey, usually compact, ostioles white or indistinct; spores dark brown, $6.0-8.5 \times 13.0-14.5\mu$
Conidiophores in culture: *Sporothrix* II
Hypoxylon vogesiaceum Pers. ex Sacc. (p. 176)
- 11''' Stromata deep purple red to maroon, spores dark brown, usually fairly large; conidiophores in culture: *Sporothrix*—*Acrostaphylus* 12
- 12 Ectostroma dull vinaceous; spores naked, $5.5-9.5 \times 10.5-25.0\mu$
Conidiophores variable in culture: *Sporothrix* I—II, and IV
Hypoxylon fuscum Pers ex Fr. (p. 178)
- 12' Ectostroma yielding conspicuous vinaceous particles on microscopic examination; spores with conspicuous hyaline sheaths, $6.5-9.5 \times 13.0-20.0\mu$
Conidiophores in culture: *Acrostaphylus*
Hypoxylon rubrostromaticum Miller (p. 182)
- 13 (3) Interior of ectostroma deep yellow-orange at sight; usually refractive; spores $4.0-6.5 \times 8.0-13.0\mu$
Conidiophores in culture: *Sporothrix* II, IV—V
Hypoxylon bicolor E. & E. (p. 184)
- 13' Interior of ectostroma dark at sight, vinaceous or orange on microscopic examination 14
- 14 Spores $5.5-6.0 \times 10.0-13.0\mu$
Hypoxylon argillaceum Pers. ex Berk.
- 14' Spores $7.0-8.0 \times 15.5-17.0\mu$
Conidiophores in culture: *Sporothrix* IV
Hypoxylon novemexicanum Miller (p. 189)
- 15 (4) Stromata glomerular to effuse but usually without well developed basal tissue, never hemispheric or massive in construction 16
- 15' Stromata large, globose, hemispheric or planoconvex with massive basal tissue as in species of *Daldinia*; if applanate then basal tissue exceeds one-half the height of the stroma 25
- 16 Ectostroma corky, not greatly refractive; stromata usually small pulvinate or globose, containing one to many perithecia evident in outline or loosely coalesced 17
- 16' Ectostroma brittle and refractive; stromata rarely uniperitheciate 18
- 17 Stromal surface dull yellow brown; interior yellow; spores $6.0 \times 12.5\mu$
Hypoxylon notatum B. & C.
- 17' Stromal surface orange to orange brown; interior orange; spores $7.0 \times 15.5\mu$
Conidiophores in culture: *Sporothrix* III
Hypoxylon aureostroma Martin nov. sp. (p. 166)
- 18 (16) Stromata with lateritic orange, orange yellow or yellow surface 21
- 18' Stromata with brown, red or red-purple surface 19
- 19 Stromata pulvinate to aplanate, crustose, with characteristic granulate maroon purple surface; conidia profuse and rapidly formed in culture; ascospores $4.0-5.5 \times 9.5-11.5\mu$
Conidiophores in culture: *Sporothrix* II
Hypoxylon occidentale Ellis & Morgan ex Martin (p. 191)

- 19' Stromata as above but smooth and varying to red brown; conidia as above; ascospores $4.0-5.5 \times 9.0-12.0\mu$
Conidiophores in culture: *Sporothrix* I, III
Hypoxyton subchlorinum Ellis & Calkins (p. 192)
- 19'' Stromata and conidia as for preceding species; ascospores varying to black $4.5-5.5 \times 9.5-12.5\mu$. Entostroma often disintegrates after maturity.
Tropical distribution (Central & S. America)
Conidiophores in culture: *Sporothrix* II
Hypoxyton albostigmatosum Spegazzini (p. 190)
- 19''' Stromata usually rather restricted, pulvinate or aplanopulvinate, smooth; entostroma solid; conidia otherwise 20
- 20 Surface purple-red to yellow or rusty brown; spores $4.0-6.5 \times 8.0-13.0\mu$
Conidiophores in culture: *Sporothrix* II, IV—V
Hypoxyton bicolor E. & E. (p. 184)
- 20' Surface dull purple-red; spores $7.0-8.0 \times 15.5-17.0\mu$, strongly inequilateral
Conidiophores in culture: *Sporothrix* III
Hypoxyton novemexicanum Miller (p. 189)
- 20'' Surface purple-red; spores $5.0-10.0 \times 10.0-23.5\mu$
Conidiophores in culture: *Sporothrix* II
Hypoxyton croceoplum B. & C. (p. 188)
- 21 (18) Perithecial vertices sharply conical, often raised above the stromal surface; spores $4.0-4.5 \times 7.5-8.0\mu$. Preference for *Fagus* wood.
Hypoxyton rutilum Tul.
- 21' Perithecial vertices usually not raised, if so then rounded 22
- 22 Perithecia close crowded in the stromata, elongate ovate to tubular, easily separating; stromata rapidly disintegrating after maturity leaving orange fragments; spores $6.0-7.0 \times 12.0-15.0\mu$
Conidiophores in culture: *Acrostaphylus*
Hypoxyton haematostroma Mont. (p. 195)
- 22' Perithecia close crowded or adjacent, oval to globose, not easily separable; stromata persistent; spores smaller 23
- 23 Stromata yellow to yellow orange, usually restricted in size; spores $4.0-6.5 \times 8.0-13.0\mu$
Conidiophores in culture: *Sporothrix* II, IV—V
Hypoxyton bicolor E. & E. (p. 184)
- 23' Stromata lateritic orange, usually effuse 24
- 24 Spores $3.5-4.0 \times 7.0-9.5\mu$; conidiophores: *Acrostaphylus*
Hypoxyton jecorinum Berk. & Rav. (p. 196)
- 24' Spores $4.0-6.0 \times 8.0-12.0\mu$; conidiophores in culture: *Sporothrix* II, IV, fertile branches verticillate and often narrowing distally as in *Trichoderma*
Hypoxyton hypomiltum Mont. (p. 193)
- 25 (15) Stromata globose, hemispheric or small pulvinate, with well developed black basal tissue and orange brown ectostroma. With *Graphium* coremial stage in circlet around stroma 26
- 25' Stromata aplanopulvinate, planoconvex or large pulvinate 27
- 26 Spores $5.0-6.5 \times 11.0-13.0\mu$
Conidiophores in culture: *Sporothrix* II
Hypoxyton fragiforme (Pers. ex Fr.) Kickx (p. 198)
- 26' Spores $3.5-5.0 \times 7.5-9.5\mu$
Conidiophores in culture: *Sporothrix* II
Hypoxyton howeianum Peck (p. 200)
- 27 (25) Stromal surface bright coloured, saffron to orange yellow; ectostroma yellow; entostroma corky. Spores $3.5 \times 8.5\mu$
Conidiophores in culture: *Sporothrix* II
Hypoxyton daldiniforme Martin nov. sp. (p. 202)

- 27' Stromal surface coloured otherwise; ectostroma not visibly coloured; entostroma rigid, sometimes with a degree of carbonization 28
- 28 Stromal surface brown; ectostroma refractive, deep orange; spores $6.0 \times 12.5\mu$
Hypoxylon mulleri Mill.
- 28' Stromal surface dark brown to purple; ectostroma refractive, vinaceous; spores $5.5-8.0 \times 11.0-17.0\mu$
 Conidiophores in culture: *Acrostaphylus*
Hypoxylon sclerophaeum Berk. & Curt. (p. 202)
- 28'' Stromal surface yellow ochre, yellow orange or greenish-brown; ectostroma refractive, yellow; spores $7.5-8.0 \times 12.5-16.0\mu$
Hypoxylon papillatum E. & E.

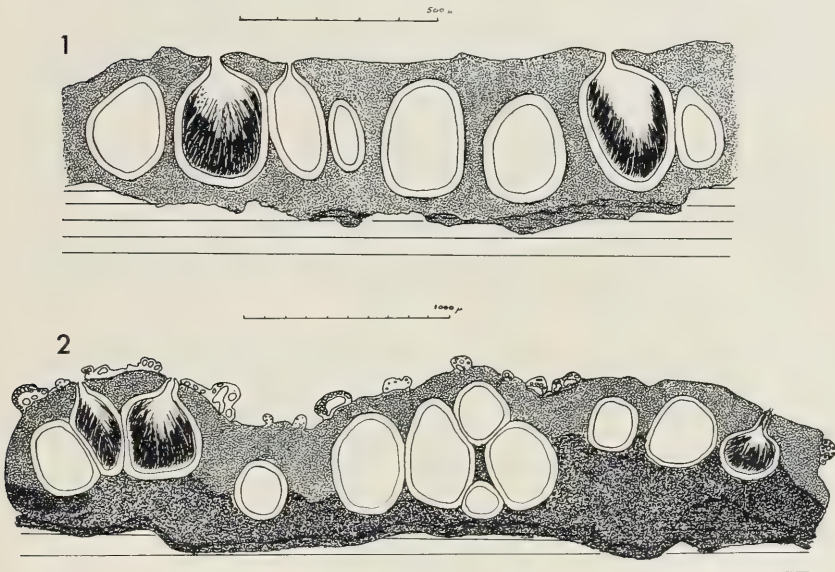


FIG. I. Stromata in vertical section.

1. *Hypoxylon sphaeriosporum*, interior concolorous.
2. *Hypoxylon fuscum*, differentiated into light exterior and darker interior, corresponding roughly to ectostroma and entostroma.

The Oodes Series.

Members of this group bear certain resemblances to the *Entoleuca* and *Papillata* groups. In contrast to the next two series, the species are relatively easy to distinguish.

1. *Hypoxylon oodes* Berk. & Br. (Plate I: 10, 11)

- Berkeley M. J. & C. E. Broome Jour. Linn. Soc. **14**, 122, (1873). Cooke M. C. Handbook of Australian Fungi 295, (1892). Miller J. H. Monog. Univ. Puerto Rico B. **2**, 203, (1934). World Species of *Hypoxyton* 21, (1961). Petch T. Ann. roy. bot. gard. Perad **8**, 157, (1924).
- sub *Hypoxyton lenormandi* Berk. & Curt.
Berkeley M. J. Jour. Linn. Soc. **10**, 385, (1869).
- sub *Rosellinia calami* Henn.
Hennings P. Hedwigia **42**, (79), (1903).
- sub *Rosellinia melaleuca* E. & E.
Ellis J. B. & B. M. Everhart Bull. Lab. Nat. Hist. Univ. Iowa **2**, 402 (1893).
- sub *Rosellinia molleriana* Hennings non Winter
Hennings P. Hedwigia **41**, 13, (1902). Rehm H. Leaflets.
Philipp. Bot. **6**, 1937, (1913); Ibid **8**, 2941, (1916).
Rick J. Brotéria Ser. cienc. nat. **1**, 188, (1932). Theissen F. Beih. Bot. Cent. **27**, 395, (1910).

Stromata globose to pulvinate or aplanate depending on the degree of association of perithecia, $0.4-16 \times 0.4-43 \times 0.5-1.5$ mm. Surface of stroma white, dull pink, vinaceous, fawn, reddish brown, or burgundy colour, with a smooth matt veneer sometimes interrupted by black areas around the ostioles; interior of ectostroma rarely brittle refractive, normally corky, vinaceous or dark at sight, sometimes showing vinaceous particles on microscopic examination, sometimes not. Entostroma slight, dull brown to black. Perithecia one to many per stroma, spaced well apart or adjacent, evident to base or only at the vertices, globose to ovate, $300-600 \times 400-700\mu$; ostioles umbilicate, sometimes raised or even papillate. Asci cylindric, $100-190 \times 4-8\mu$; stipes $30-100\mu$. Spores gibbous, navicular or crescentic, with narrow ends, dark brown, $3.5-7.5 \times 7.5-16.5\mu$, ave. $5.3 \times 11.2\mu$.

Material examined:

Martin 906; Mazatlán, Sinaloa, Mexico, (1961). Martin 974, 993, 1512, 1526; San Blás, Nayarit, Mexico, (1961, 1962). Martin 1107; Columbia, Mo., U.S.A., (1962). Martin 1151, 1156; Lake Ozark, Mo., U.S.A., (1962). Martin 1806 ex Carroll 576; Rivercrest, Austin, Texas, U.S.A., (1963); Martin 1824; ex Kramer, Allen Co., Kansas, U.S.A., (1963). Rick 28; Sao Leopoldo, Brazil, (1904), (NYBG). Rogers 1600; on *Artocarpus incisus*,

PLATE II Variation in Stromal colour. All $\times 1$; except 16, 17, 19 $\times 0.3$

- 1-4. *Hypoxyton rubiginosum*
 1. typical aplanopulvinate
 2. young stage
 3. mummularioid, aplanate
 4. aplanate with scattered perithecia
5. *Hypoxyton sphaeriosporum*
6. *Hypoxyton rubiginosum* forma *trichocladi*
7. *Hypoxyton ferrugineum*
8. *Hypoxyton vogesiaceum*
9. *Hypoxyton denudatum* (Annulata group) for comparison
10. *Hypoxyton fuscum*
- 11, 12. *Hypoxyton bicolor*, yellow and reddish purple forms
- 13, 14. *Hypoxyton crocopleum*, pulvinate and effuse forms
15. *Hypoxyton hypomiltum*, young
16. *Hypoxyton murcidum*, yellow initial stage
17. *Hypoxyton croceum*, salmon pink conidial growth
18. *Hypoxyton aureostroma*
19. *Hypoxyton daldiniiforme*



- Marshall islands, (1946), (NYBG). Thaxter 6617; Palm Beach, Fla., U.S.A., (1897-1898), (NYBG).
- sub *Hypoxylon rubiginosum* v. *gregaria*
Morgan 1097; Ohio, (details incomplete), (NYBG),
- sub *Hypoxylon vinoso-purpureum*
Langlois 2157; St. Martinsville, La., U.S.A. (1889), (NYBG).
- sub *Rosellinia calami*
Merrill, Flor. Philippines 8481; on *Bambusa* sp., Luzon, Manila, Philippines, (1912), (NYBG).
- sub *Rosellinia melaleuca*
Earle & Murrill 234; San Antonio de los Baños, Havana province, Cuba, (1905), (NYBG).
Seaver in NYBG West Indian Explor. 798; St. Thomas, Puerto Rico, (1923), (NYBG).
Smith, Central Amer. Fungi 11; Ometepe, Nicaragua, (1893), (NYBG), (stated as type).
- sub *Rosellinia mutans*
Webber; Lincoln. Neb., U.S.A., (1889), (NYBG).

Cultural characters: (Plate IV: 6; Plate V: 3)

Colonies felty to velvety or cottony, with fine or coarse texture, without mycelial aggregates; margin not distinct, hyphae dispersed or lying together. Aerial mycelium pure or dull white. Conidia appear by a week, or when old. Stain red brown or amber. Growth rate moderate, 2·6—3·2 mm./day at 25°C.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 2·3 μ . Secondary mycelium loose or ropy, 1·5—5·6 μ diam.

Conidiophores and conidia: (Plate VII: 1—2; Plate X: 9).

This species has a *Graphium* type coremium which is frequently seen in connection or association with stromata. These coremia are 100—210 x 200—800 μ , ropy, separate or joined, unbranched or rarely bifurcate, aristate, dull brown, and fertile over the apices only. Coremia have not been observed in culture.

Conidiophores produced in culture are somewhat similar to those of *H. investiens*, usually smooth walled and colourless but sometimes warted and tinted dull brown, 140—840 x 1·8—2·7 μ . Axes are branched dichotomously or ternately to the first degree or indefinitely, over the upper parts or apices only; otherwise growth may be sympodial. Fertile branches are usually smooth but sometimes irregular in outline, lying free or in trident formation, with unmodified apices, 13—105 x 1·8—2·5 μ . Conidia in fascicles off the sides of the hyphae, pleurocrogenous or acrogenous, sessile, clavate with narrow bases, white or pink, 1·2—2·3 x 3·2—4·7 μ , ave. 1·8 x 3·9 μ .

This species is intermediate between three groups of *Hypoxylon*: similar to *Entoleuca* in having separate perithecia and occasional papillate ostioles, similar to *Papillata* in the nature of coremia and conidiophores, and similar to *Euhypoxylon* in general stromal characters. These similarities are noticeable in other members of the *Oodes* and *Fragiforme* series but are not present together as in this species.

2. *Hypoxylon croceum* Miller (Plate II: 17)

Miller J. H. *Mycologia* 25, 323, (1933); *Monog. Univ. Puerto Rico* B 2, 199, (1934); *World Species of Hypoxylon*, 55, (1961).

Stromata aplanate, crustose, sometimes uniperitheciate and globose, superficial on bark and decorticated wood, $0.6-7.0 \times 1.1-21 \times 0.7-1.5$ mm, often seen in association with salmon pink conidial masses, but no definite coremia. Ectostroma reddish brown to brown as in *H. investiens*, similarly often varying in colour from one part to another and becoming dull black in age. Interior of ectostroma is reddish brown, while the entostroma, below the perithecia, is dark brown to black, usually contrasting sharply. Perithecia evident to base or only vaguely evident above the stroma level, globose to oval, $350-650 \times 400-700\mu$; ostioles raised but not distinct or invisible and at stroma level, or clearly umbilicate. Asci cylindric, $82-173 \times 4-7\mu$; stipes $33-90\mu$. Spores very variable in shape, equilateral to navicular, ranging from subglobose to narrowly elliptic, often within the same sample; elliptic spores usually with one end blunt and the other tapering; medium brown to dark brown or greyish brown, $3.0-7.0 \times 7.5-14.5\mu$, ave. $4.6 \times 9.9\mu$.

Hosts: *Lycium campanulatum*, *Quercus* spp., *Virgilia oroboides*.

Material examined:

Miller 1815, 2198, 2199; on *Liriodendron tulipifera*, Barron Playhouse, Rabun, Ga., U.S.A., (1929 & 1932) (Mill). Martin 418; Fish River Valley, nr. Grahamstown, E. Cape South Africa, (1958). Martin 561; Nature's Valley, Knysna District, Western Cape, South Africa, (1959). Martin 1149, 1151, 1156, 1171, 1178; Lake Ozark, Mo., U.S.A., (1962).

Cultural characters: (Plate IV: 1, 5; Plate VI: 1)

Colonies canescent to thin appressed velvet; smooth with dull white subhyaline aerial mycelium. Margin entire, compact to slightly effuse, not distinct. After 4 days conidia develop profusely over the entire colony, which then turns salmon pink in colour. Stain absent or diffuse pale willow green. Growth on other media is similar except for Czapek where it is much less luxuriant. Growth normally fast, occasionally moderate, $2.5-5.3$ mm. per day at 25°C .

Microscopic characters:

Primary mycelium undiagnostic; marginal hyphae with a maximum diameter of 2.3μ . No secondary mycelium.

Conidiophores and conidia: (Fig. II: 12)

Conidiophores usually distinct from the vegetative mycelium by the whorled or verticillate nature of the ultimate branches which are sometimes also rather highly refractive when viewed dry under a coverslip; $120-560 \times 1.2-3.7\mu$, branched to the first degree to indefinitely over the entire length of the main axes or over their upper halves only; branching rarely dichotomous, usually



verticillate with 3—6 branches per verticil. Fertile branches lying freely, occasionally somewhat geniculate (cf *Nodulisporium*) with elliptic, blunt or slightly swollen apices, $6.2\text{--}31 \times 1.2\text{--}1.9\mu$. Conidia in apical clusters, in short pleurocrogenous spikes, or in groups off the hyphae; sessile or on slender sterigmata, elliptic equilateral or narrow clavate, with bluntly pointed ends, ranging from salmon pink to red brown or brick orange collectively, $1.2\text{--}2.3 \times 4.2\text{--}6.0\mu$, ave. $1.6 \times 4.6\mu$.

3. *Hypoxylon riograndense* Rehm.

Rick J. Brotéria Ser Bot **25**, 33 (1931). Theissen F. Ann. Mycol. **7**, 154, (1909)

Stromata crustose, orbicular, linear, or irregularly aplanopulvinate, superficial, $1.1\text{--}24 \times 2.8\text{--}10 \times 60.4\text{--}1.7$ mm. Colour characteristically purple-red, sometimes violaceous to maroon, turning black with age. Ectostroma smooth; interior not clearly differentiated; granular particles normally not conspicuous but sometimes dull red. Entostroma slight, dull brown to black, corky. Perithecia one to several per stroma, with evident vertices or completely immersed, loosely coalesced to adjacent, sometimes close-crowded, ovate, $200\text{--}500 \times 200\text{--}700\mu$; ostioles not visible or normally umbilicate. Asci cylindric, $60\text{--}110 \times 4\text{--}6\mu$; stipes $9\text{--}60\mu$. Spores equilateral, amber to pale brown, subhyaline to opaque, $3.0\text{--}7.0 \times 5.0\text{--}15.0\mu$, ave. $4.1 \times 8.2\mu$.

South African hosts: Wood unidentified.

Material examined:

sub *Hypoxylon jecorinum*

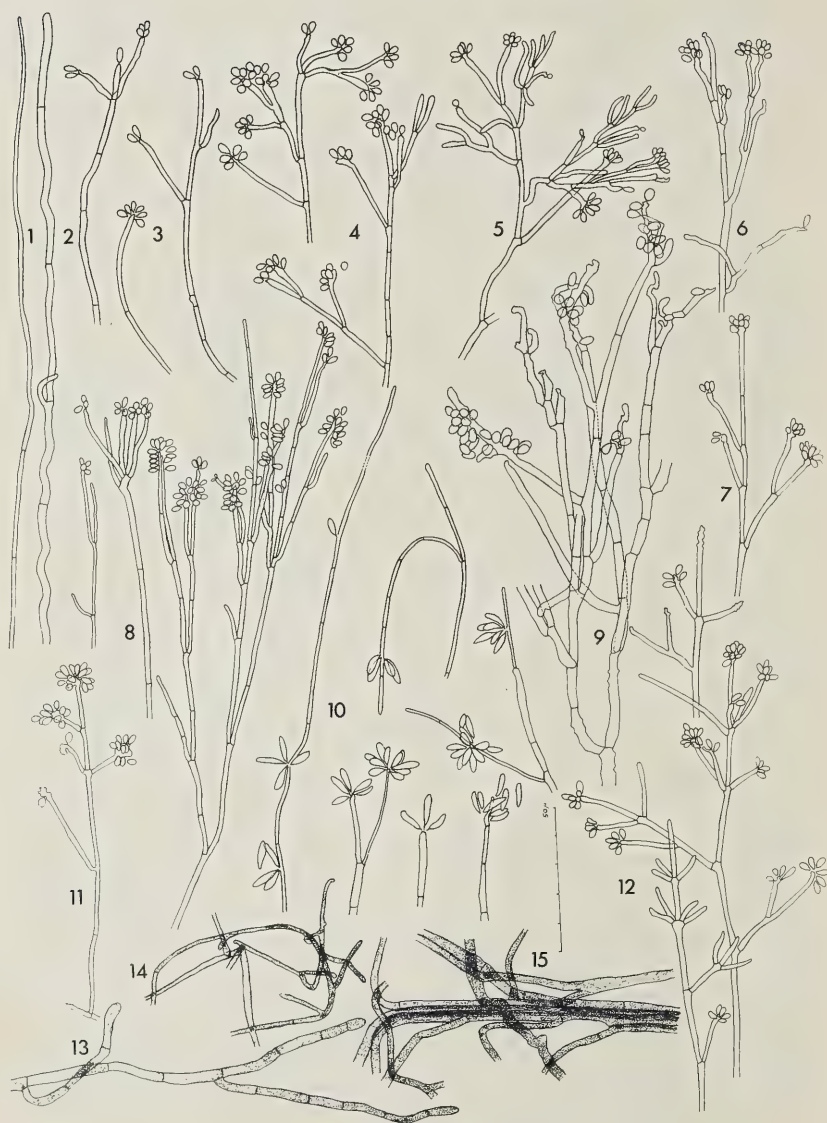
Kauffmann; Hot Springs, North Carolina (1924), (AA).

sub *Hypoxylon riograndense*

Martin 534; Highlands Mtn., Albany District, E. Cape, South Africa, (1959). Martin 977, 978, 987; San Blàs, Nayarit, Mexico, (1961). Rick; Brazil, (1907), (AA).

PLATE III Variation in Colony colour. Cultures on malt, 2 weeks old at 25°C, except where stated.

- 1—2. *Hypoxylon rubiginosum*
3. *Hypoxylon sphaeriosporum*
4. *Hypoxylon plumbinum*, on Czapek
5. *Hypoxylon vogesiacum*
- 6, 7. *Hypoxylon fuscum*
- 8—10. *Hypoxylon bicolor*
- 11, 12. *Hypoxylon novemexicanum*
13. *Hypoxylon croceoplum*
- 14—16. *Hypoxylon aureostroma*
- 17—20. *Hypoxylon rubiginosum* showing extremes
- 17—18 On malt
- 19—20 On Czapek
21. *Hypoxylon vogesiacum*
22. *Hypoxylon plumbinum*, on Czapek
23. *Hypoxylon murcidum*
24. *Hypoxylon rubiginosum* forma *trichocladi*



Cultural characters (Plate V: 9; Plate VI: 2)

Colonies first appressed later felty with a coarse surface, later becoming denser and velvety, with dull white to olive brown aerial mycelium. Margin entire, not distinct; hyphae lying close together. Conidia appearing in granulate masses, immediately or with age; white to very pale grey. Stain at first orange yellow, orange red or roseate, turning red-brown with age. Appearance on other media similar to that on malt, but less luxuriant, and with greenish brown stain on maize, and with grey aerial mycelium and deep ochre stain on Czapek. Growth rate moderate to fast; 3·6—7·6 mm/day at 25°C.

Microscopic characters: (Fig. II: 2)

Primary mycelium unspecialized, with maximum diameter of 2·7 μ . Secondary mycelium uniform, loose or ropy, 1·4—3·8 μ diam.

Conidiophores and conidia: (Plate VIII: 4)

Conidiophores distinct from the vegetative mycelium by the verticillate branching and shorter ultimate branches; 50—300 $\times$ 2·5—2·8 μ , sometimes dichotomously but usually ternately or multi-branched to the second degree. Axes of conidiophores sometimes tinted dull brown. Fertile branches 7·5—35 $\times$ 1·2—1·5 μ , straight or somewhat curved, in trident formation, normally with unmodified apices. Conidia borne in apical clusters of 3—8, sessile, clavate to oval-elliptic, with narrow bases, white collectively, 1·2—2·3 $\times$ 2·9—5·0 μ , ave. 1·6 $\times$ 3·7 μ .

4. *Hypoxylon murcidum* Berk. & Br. (Plate I: 3, 7; Plate II: 16)

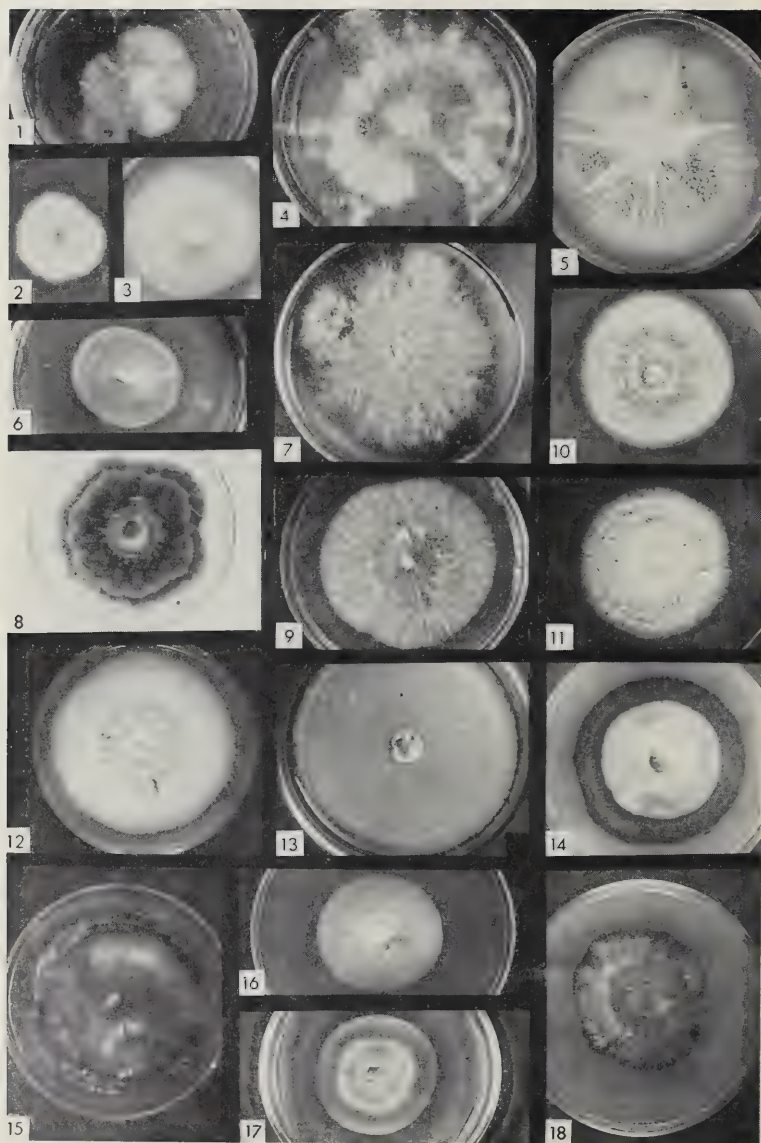
Berkeley M. J. & C. E. Broome Jour. Linn. Soc. **14**, 123, (1875).

Stromata aplanate or aplanopulvinate, consisting of a matrix in which the perithecia develop independently, so that at maturity they may be separated or

FIG. II. Microscopic characters.

- 1—2 Variation in marginal hyphae
 - 1. *Hypoxylon bicolor*
 - 2. *Hypoxylon riograndense*
- 3—12 Conidiophores and conidia
 - 3. *Hypoxylon rubiginosum*, *Sporothrix* types I—II
 - 4. *Hypoxylon vogesiacum*
 - 5. *Hypoxylon croceopileum*
 - 6. *Hypoxylon daldiniforme*
 - 7. *Hypoxylon fuscum*
 - 8. *Hypoxylon plumbinum*
 - 9. *Hypoxylon viridicolor*
 - 10. *Hypoxylon murcidum*, *Sporothrix* type I
 - 11. *Hypoxylon novemexicanum*, *Sporothrix* type III
 - 12. *Hypoxylon croceum*, *Sporothrix* type IV

} *Sporothrix* type II
- 13—15 Secondary mycelium
 - 13. *Hypoxylon vogesiacum*
 - 14. *Hypoxylon rubiginosum*
 - 15. *Hypoxylon daldiniforme*



coalescent. The globose outline of the mature perithecia, indistinct or minutely papillate ostioles, brilliant yellow initial stage and deep purple surface colour at maturity serve to distinguish this species from *H. rubiginosum* where it was placed by Miller (1961), and from other very similar species—*H. occidentale*, *H. dieckmanni* & *H. riograndense*. Ectostroma refractive, breaking into red vinaceous particles; entostroma slight, reddish black. Perithecia evident to base or only vaguely evident, globose to ovate, $250\text{--}350 \times 250\text{--}400\mu$. Asci cylindric, $105\text{--}160 \times 6\mu$; stipes $35\text{--}70\mu$. Spores elliptic; equilateral navicular, or crescentic, amber to dark brown, $4.5\text{--}7.0 \times 8.5\text{--}15.0\mu$, ave. $5.3 \times 11.7\mu$.

South African hosts: Olea capensis.

Material examined:

sub *Hypoxylon glomeratum*

Johnston 986, Fajardo, Puerto Rico, (1913), (NYBG)

sub *Hypoxylon murcidum*

Martin 470, 481, 1044, 1053; Nature's Valley, Knysna District, Western Cape, South Africa. Twaite 1083; Ceylon (details incomplete), (Mill.).

Cultural characters (Plate III: 23)

Colonies at first submersed and hyaline, later developing sparse appressed white subhyaline aerial mycelium and finally after 2 weeks a thin aerial mat gradually becoming dense velvety with age. Surface fine and smooth, becoming granulate after development of pale grey conidia. Colour of mature colonies mouse grey. Margin distinct, 3–6 mm., hyphae close together. Stain at first roseate to brandy colour, later deepening and finally turning dull grey black. Appearance on other media similar but restricted on Czapek: mycelium white, tinted pale red, stain deep red and spreading beyond the colony border. Growth moderate 2.9 mm/day at 25°C.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 2.6μ . Secondary mycelium reticulate, $1.9\text{--}2.9\mu$ diam.

Conidiophores and conidia:

Conidiophores little differentiated from the vegetative mycelium, $75\text{--}190 \times 1.2\text{--}2.5\mu$, unbranched or branched once dichotomously, very lax, with conidia

PLATE IV Young plate cultures. 1–3, 6, 9, 10–11, 16–17; 7 days old
4–5, 7–8, 12–15, 18; 14 days old
On malt agar at 25°C.

- | | |
|--------------------------------------|-------------------------------------|
| 1. <i>Hypoxylon croceum</i> | 11. <i>Hypoxylon fuscum</i> |
| 2, 3, 4. <i>Hypoxylon plumbinum</i> | 12. <i>Hypoxylon sphaeriosporum</i> |
| 5. <i>Hypoxylon croceum</i> | 13. <i>Hypoxylon fuscum</i> |
| 6. <i>Hypoxylon oodes</i> | 14. <i>Hypoxylon viridicolor</i> |
| 7. <i>Hypoxylon dieckmanni</i> | 15. <i>Hypoxylon hypomilum</i> |
| 8. <i>Hypoxylon novemexicanum</i> | 16. <i>Hypoxylon bicolor</i> |
| 9. <i>Hypoxylon rubrostromaticum</i> | 17. <i>Hypoxylon croceopeplum</i> |
| 10. <i>Hypoxylon ferrugineum</i> | 18. <i>Hypoxylon daldiniiforme</i> |

in fascicles or in small apical clusters. Fertile branches often distinctly narrower distally, $25-53 \times 0.7-2.3 \mu$, with unspecialized apices. Conidia borne on slender sterigmata, with narrow rounded or acute apices, linear, pale grey en masse, $1.7-2.6 \times 6.6-17.1 \mu$, ave. $2.0 \times 8.7 \mu$.

This species can be clearly distinguished from *H. rubiginosum* on account of the ascospore characters and occasional papillate ostioles. The cultural characters are also quite distinct. The conidia are similar to those of *H. dieckmanni* in their extreme length.

5. *Hypoxylon aureostroma* Martin, sp. nov. (Plate II: 18)

Stromata cum paucis peritheciis, fere pulvinata, aurea; ab *Hypoxylon haematostroma* peritheciis globosis differtur; sporae fuscae, $4.5-8.5 \times 12.5-25.5 \mu$, medius $7.0 \times 15.5 \mu$.

Stromata pulvinate, glomeruliform, or aplanopulvinate, $1.5-5.0 \times 1.8-8.0 \times 0.8-1.7$ mm. Initial layer orange-yellow, surface of mature stroma yellow orange or yellow ochre. Ectostroma corky, orange red or orange yellow at sight, yielding yellow or orange particles in microscopic preparations; entostroma well-developed, dull brown to black. Perithecia evident to base or only at the vertices, globose to ovate, spaced well apart or adjacent, $350-800 \times 450-1000 \mu$; ostioles umbilicate and fairly conspicuous. Asci cylindric or clavate, $135-180 \times 8-10.5 \mu$; stipes $40-75 \mu$. Spores elliptic, equilateral, navicular or crescentic with short linear germ slits, medium to dark brown, $4.5-8.5 \times 12.5-25.5 \mu$, ave. $7.0 \times 15.5 \mu$.

Material examined:

sub *Hypoxylon aureostroma*

Martin 268; on *Acacia karoo*, near Alexandria, Eastern Cape, South Africa, (1958).

sub *Hypoxylon rubrostromaticum*

Thaxter, in Farlow 6880, in Miller 4648; St. Ann's Valley, Port of Spain, Trinidad, (1912-1913), (Mill.).

Cultural characters (Plate III: 14-16; Plate VI: 4)

Colonies velvety, forming a very dense smooth mat up to 2 mm. high; aerial mycelium at first white then tinted pale yellow, saffron or buff towards the centre and reddish towards the outside. After 21 days reddish brown drops are exuded over the centre. Margin not distinct; hyphae lying together. Conidia very infrequent, only appearing with age in pale pink aggregates. Stain light roseate to deep red or red-brown, uniformly diffused. Appearance on other media similar but somewhat less luxuriant; submersed on Czapek then developing radiating furrows with age. Growth rate moderate, 3.2 mm/day at 25°C.

Microscopic characters:

Primary mycelium unspecialized; maximum diameter of marginal hyphae = 1.5μ . Secondary mycelium loose, $1.5-4.3 \mu$ in diameter.

Conidiophores and conidia: (See Martin, 1967, p. 228, fig. 4)

Conidiophores with distinct sympodial branching, only at present seen in 2 other species (*H. subchlorinum*, *H. oodes*); $100\text{--}200 \times 1.5\mu$. Branching is dichotomous extending to the second degree, over the length of the main axes. Fertile branches very short, $2\text{--}22 \times 1.0\text{--}1.2\mu$ with unmodified apices. Conidia acrogenous, sessile, clavate with narrow bases, white to pale pink, $1.4\text{--}2.2 \times 3.4\text{--}4.4\mu$, ave. $2.4\text{--}4.1\mu$.

This species is possible to confuse with *H. haematostroma* but is sharply distinct on cultural grounds, apart from minor stromal differences.

The remaining species in this group, *H. notatum*, was not available for culture.

The Rubiginosum Series

Hypoxylon rubiginosum, perhaps the most common species in the genus, has acquired an enormous number of synonyms which are listed fully by Miller, (1961, pp. 26-28). Miller's conception of *H. rubiginosum* is clearly that of a number of forms linked by so many intergrades that recognition of them as separate entities is impossible. Theissen (1909, p. 147) suggested more flexibly that as many as 9 species or varieties might be included under the same term. The writer considers that at least 5 species are clearly separable from *H. rubiginosum* on a combination of stromal and cultural features. These include *H. plumbinum* Martin, material of which was sent to the late Dr. Miller and classified as a non-pigmented variant of *H. rubiginosum*, *H. sphaeriosporum* Martin, and several species considered as synonyms in his monograph: *H. murcidum* B. & Br., *H. albstigmatosum* Speg., and *H. subchlorinum* Ell. & Calkins. The last two are described in the Hypomiltum series.

The stromata can be placed in order of increasing degree of colour and internal differentiation, as follows:

6. *Hypoxylon plumbinum* Martin nov. sp. (Fig. I: 6)

Stromata elliptica vel inequalis vel fusco brunnea; ab *Hypoxylon rubiginosum* differtur pigmento sporis majorisque.

Stromata oval-elliptic or irregular in form, thin, aplanate to aplanopulvinate, superficial or erumpent through bark, $0.5\text{--}8.0 \times 0.8\text{--}2.8 \times 0.4\text{--}1.5$ mm. Surface of stroma rarely smooth, usually somewhat wrinkled; ectostroma often bearing superficial granular dark grey to black particles visible on microscopic section; colour variable, from grey to grey brown at maturity to black with age, never purple. Interior of stroma not clearly differentiated, corky, grey to brown without coloured particles; outer portion sometimes gelatinous when immature, and tinted yellow when seen in longitudinal section; entostroma beneath the perithecia rather slight in quantity. Perithecia often close crowded, in superficial stromata evident in outline with prominent conic obtuse vertices, in immersed

stromata usually not evident; globose or oval, $250-600 \times 300-700\mu$. Ostioles usually not clearly visible, more rarely umbilicate. Asci cylindric usually long stipitate, $95-230 \times 5-9\mu$. Spores elliptic, rarely equilateral, usually gibbous, navicular or somewhat crescentic, dark brown or black $4.5-8.5 \times 8.0-18.0\mu$, ave. $5.9 \times 12.7\mu$.

South African hosts:

Cassine croceum, *Olea capensis*, *Passerina falcifolia*, *Populus canadensis*, *Tarchonanthus camphoratus*, *Vepris lanceolata*.

Material examined:

sub *Hypoxylon ianthinum*

Macoun 303 in Cooke 5018, 5018 A; Bellville, Ont., Canada, (1882), (NYBG).

sub *Hypoxylon plumbinum*

Martin 17, 92, 106, 166, 376, 407, 493, 494, 498, 515, 518, 558, 560, 1024, 1036, 1037, 1040; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1959, 1962). Martin 193, 220, 547, Hogsback, nr. Alice, Eastern Cape, South Africa, (1958, 1959). Martin 277; Alexandria forest, Eastern Cape, South Africa, (1958). Martin 719; Klamath river, Northern California, U.S.A., (1961). Martin 973, San Blas, Nayarit, Mexico, (1961).

Cultural characters (Plate III: 4, 22; Plate IV: 2-4)

Colonies canescent, white subhyaline and mainly submersed or thin velvety, smooth, with opaque white aerial mycelium. Margin not distinct, or forming a broad colourless zone 2-18 mms. wide; entire, with the peripheral hyphae lying together. Conidia develop as a thin fawn-brown layer at a variable time after inoculation, in some strains by 7 days, in others only with extreme age, after 4-8 months. Stain rarely absent, typically violaceous to rose or pink, sometimes dull orange brown. On other media the margin tends to be distinct, and the stain is more intense, on Czapek often brilliant roseate orange and extending well beyond the margin of the colony. Growth slow, $0.9-2.0$ mm per day at 25°C .

Microscopic characters (Fig. II: 8):

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae = 2.7μ . Secondary mycelium absent.

Conidiophores and conidia:

Conidiophores scarcely distinct from the vegetative mycelium or recognizable as indeterminate mycelial systems, $24-690 \times 0.7-2.1\mu$ unbranched, dichotomously branched or rarely ternately and quadrately branched to the first or second degree or indefinitely, usually over the upper halves of the main axes. Fertile hyphae lying freely or less commonly in trident formation, $9-83 \times 0.6-2.0\mu$; unspecialized, with apices not swollen. Conidia strictly apical or acropleurogenous, in spicate clusters, sessile, broadly oval to oval-elliptic or clavate, with narrow bases, fawn brown collectively, $1.4-2.9 \times 2.0-5.1\mu$, ave. $2.1 \times 3.4\mu$.

This species is closely related to *Hypoxylon macrosporum* Karsten (1873)

which has been wrongly attributed by Miller (1961) to *H. mammatum* (Wahl) Miller. Type material of *H. macrosporum* (Karsten 775; on *Salix*, Karelia, Sweden, 1861) obtained by the writer from the herbarium at the University of Helsinki showed that it resembled *H. plumbinum* in all major respects except for the spores, which were large, gibbous, medium to dark brown, translucent to opaque, $7.5-12.0 \times 22.5-32.5 \mu$, ave. $10.3 \times 27.3 \mu$. Material of *H. plumbinum* sent to the late J. H. Miller was classified as one of the many variants of *H. rubiginosum* recognized by him.

7. *Hypoxylon ferrugineum* Otth. (Plate I: 9, Plate II: 7)

Cited in Miller J. H. World Species of *Hypoxylon* 32, (1961)

Stromata aplanate, characteristically erumpent, with the surface at bark level, $4.5-9.3 \times 8.1-30 \times 0.8-0.9$ mm. Surface of stroma uneven, olive or yellow green to ferrugineous. Interior of stroma not clearly differentiated. Ectostroma corky, without demonstrable coloured particles; entostroma well developed but not massive, dull brown to black. Perithecia evident at the vertices, or sometimes immersed, ovate, $400-500 \times 600-800 \mu$; ostioles usually clearly evident, wide umbilicate with white periphysate mouths. Asci cylindric, $120-160 \times 5-7 \mu$; stipes $66-100 \mu$. Spores oval, navicular to crescentic, light brown, $3.5-7.5 \times 7.5-13.0 \mu$, ave. $5.8 \times 10.8 \mu$.

South African Hosts: *Olea capensis*; apparently host-specific.

Material examined:

Martin 121, 327, 385, 386, 417, 504, 1000, 1015, 1033; Nature's Valley, Western Cape, South Africa, (1958, 1959, 1962).

Cultural characters (Plate IV: 10; Plate V: 3)

Colonies velvet felty, with coarse surface; aerial mycelium dull white, tinted olive green in parts. Margin distinct, compact, submersed, 2–9 mm broad. Conidia produced in pulvinate masses over surface of the colony in age, pale green to brown. Stain olive green or paler, deepening to dull brown. Appearance on other media similar, but less luxuriant on Czapek. Growth rate moderate, 3.4 mm/day at 25°C.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae = 2.2μ . Secondary mycelium reticulate, $1.9-3.6 \mu$ in diameter.

Conidiophores and conidia:

Conidiophores rather short, $100-200 \mu$ long, with axes $1.2-1.5 \mu$ in diameter, compactly multibranched dichotomously or ternately over the upper parts of the main axes. Fertile branches lying freely, $15-75 \times 1.2-1.5 \mu$, with

unspecialized heads. Conidia acrogenous, sessile, short clavate with narrow bases, olive green to brown, small in relation to those of other species, $1.4-2.3 \times 2.0-4.0\mu$, ave. $1.9 \times 2.7\mu$. These are the smallest conidia in the entire species group.

8. *Hypoxyton dieckmanni* Theiss. (Plate I: 3)

Miller J. H. World Species of *Hypoxyton* 33, (1961)

Rick J. Brotéria Ser. Bot. 25, (1931). Theissen F. Annales Mycol. 6, 346 (1908); Ibid 7, 153, (1909).

Stromata aplanate or aplanopulvinate, crustose, linear or irregular in shape, $2.2-18 \times 3.5-89 \times 0.9-1.3\mu$. Colour characteristically deep purple-red at maturity. Ectostroma smooth, breaking into dull red vinaceous particles. Entostroma slight, dull brown to black, corky. Perithecia several per stroma, in palisade formation, evident at vertices or vaguely evident, $400-500 \times 500-600\mu$; ostioles at stroma level and not visible. Asci cylindric $100-120 \times 4.5\mu$; stipes $42-54\mu$. Spores equilateral oval, rather small, with broad rounded ends and sometimes nearly parallel sides, amber, pale or dark brown, $3.0-4.5 \times 6.5-11.5\mu$, ave. $3.9 \times 8.3\mu$.

Material examined:

sub *Hypoxyton dieckmanni*

Kevorkian 15 = Miller 2344; Soledad, Cuba, (1935), (Mill.) Martin 1097, 1098; Columbia, Mo., U.S.A., (1962). Martin 1169, 1177; Lake Ozark, Mo., U.S.A., (1962). Rick, Brazil, (1908?), (Mill.). Rogers 1671; Marshall Islands, (1946), (NYBG).

sub *Hypoxyton investiens*

Brace 9629; New Providence, Bahamas, (1919), (NYBG).

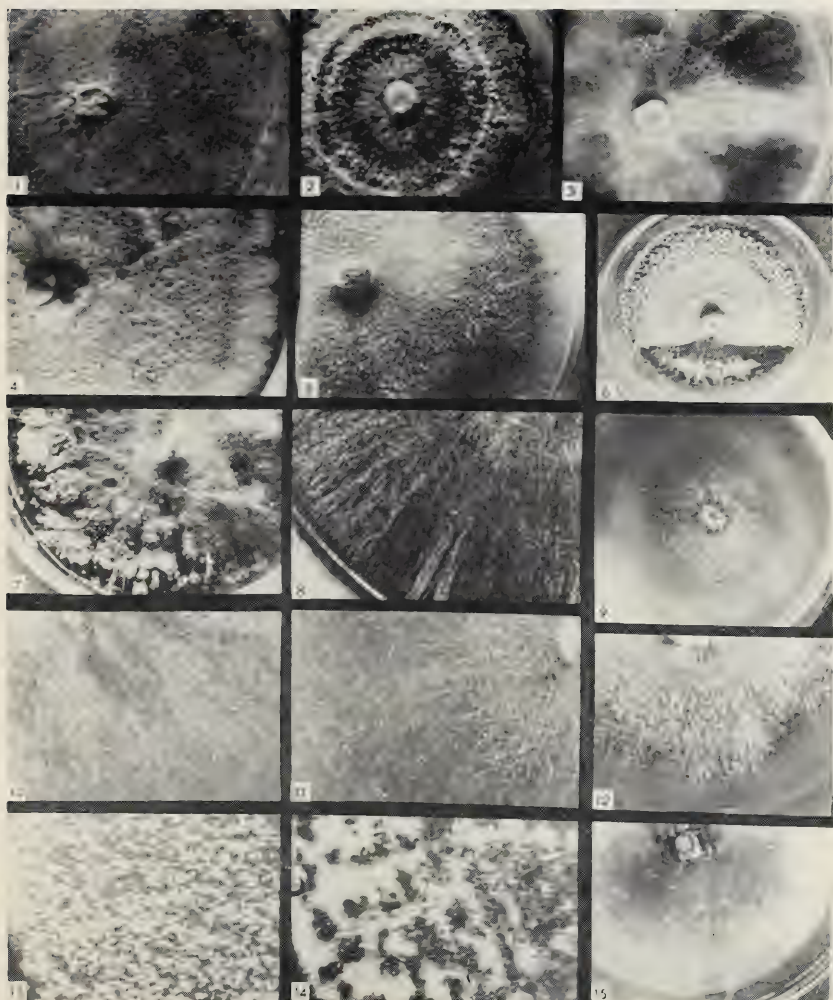
Cultural characters (Plate IV: 7; Plate V: 12)

Colonies at first submersed and hyaline, later developing canescent, felty or cottony, coarse dull white aerial mycelium spreading freely over the surface of

PLATE V Details of colony surface malt; plates, 21 days at 25°C when old.

- 1, 2. *Hypoxyton bicolor*: fine and coarse texture
3. *Hypoxyton oodes*: fine texture
4. *Hypoxyton howeianum*: mycelial aggregates of secondary mycelium dispersed throughout; inoculum pleomorphic
5. *Hypoxyton subchlorinum*: mycelial aggregates as above but smaller and marginal in distribution
6. *Hypoxyton rubiginosum*: mycelial aggregates of mostly primary mycelium
7. *Hypoxyton fragiforme*: coarse interior, conspicuous marginal conidial areas
8. *Hypoxyton crocopeplum*: conidia along linear strands of mycelium
9. *Hypoxyton riograndense*:
10. *Hypoxyton fuscum*:
11. *Hypoxyton rubrostromaticum*:
12. *Hypoxyton dieckmanni*:
13. *Hypoxyton albostigmatosum*: immediate and profuse conidial formation
14. *Hypoxyton haematostroma*: colony on blotting-paper showing dark mycelial aggregates with conidiophores
15. *Hypoxyton sclerophaeum*: colony with straggling surface, dark mycelial aggregates towards exterior

the medium, and becoming dense velvety with age. Margin not distinct, hyphae lying close together. Conidia fawn brown, developing immediately. Stain dull buff brown. Growth rapid, 6.1 mm/day at 25°C.



Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 1.2μ . Secondary mycelium rosy, $2.5\text{--}4.7\mu$ diameter.

Conidiophores and conidia (Plate VIII: 1-3) See also Martin (1967), p. 228 fig. 6 sub *H. murcidum*.

Conidiophores sharply differentiated from the vegetative mycelium, often with broad main axes, sometimes warted, $75\text{--}310 \times 1.2\text{--}3.5\mu$; rarely unbranched, usually branched in verticils to the first or second degree over the upper parts of the main axes, with 2—5 branches in each verticil. Fertile branches lying free or in trident formation, $10\text{--}18 \times 1.2\text{--}2.5\mu$ with unmodified or slightly swollen apices. Conidia produced on slender sterigmata, normally acrogenous, rarely in fascicles off the sides of the hyphae, long pyriform, linear elliptic or almost cylindrical, with narrow rounded distal ends, fawn brown en masse, $0.9\text{--}1.3 \times 3.7\text{--}5.3\mu$, ave. $1.2 \times 4.7\mu$.

This species can be clearly distinguished from *H. rubiginosum* in culture on account of the ascospore characters and the characters of the imperfect stage.

9. *Hypoxylon rubiginosum* Pers. ex Fr. (Plate I: 3; Plate II: 1-4)

The following are the most relevant publications. For others see Miller (1961).

sub *Hypoxylon rubiginosum*

Dennis, R. W. G., British Cup fungi, 177, (1960). Ellis J. B. & B. M. Everhart N. Amer. Pyren., 645 (1892). Fries, E. M. Syst. Mycol., 340, (1823); Summa Veg. Scand., 384, (1849). Jacewski, A. L. Bull. Soc. Myc. de France 11, 118, (1895). Miller, J. H. Mycologia 20, 315, (1928); Trans. Brit. Mycol. Soc. 15, 144, (1930); Monog. Univ. Puerto Rico, B, 2, 203, (1934); Bothalia, 4, 258, (1942); World Species of *Hypoxylon*, 26, (1961). Theissen, F. Ann. Mycol. 7, 147, (1909).

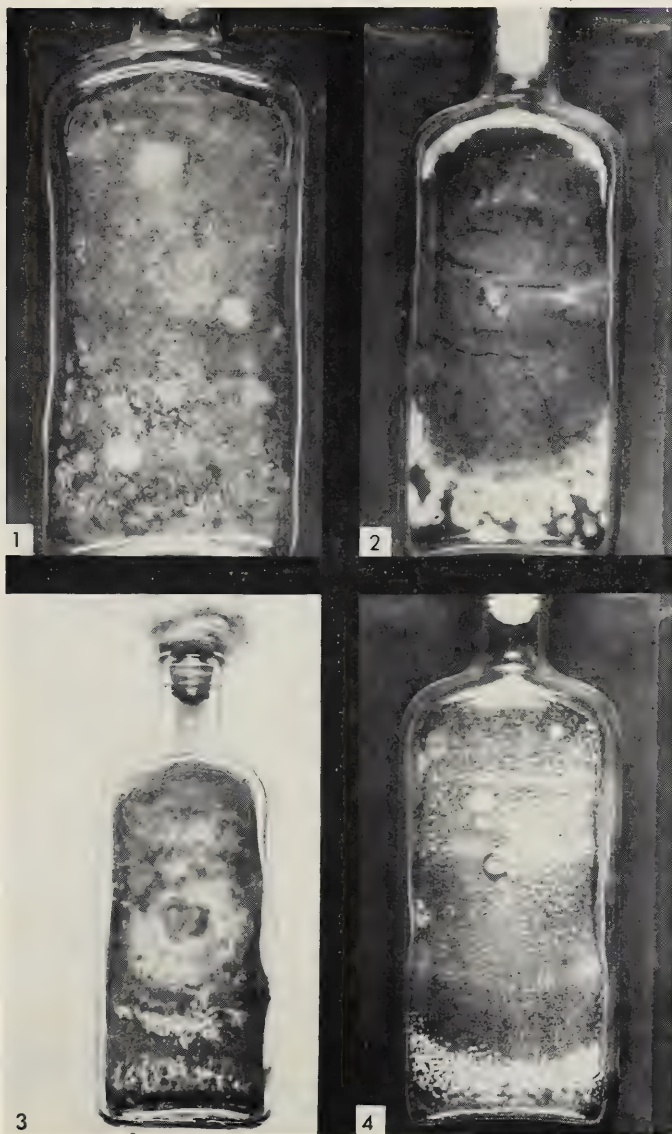
sub *Sphaeria rubiginosa* Persoon

Persoon, C. H. Obs. Mycol. 69, (1796); Syn. Meth. Fung., 11, (1801-1808).

Stromata variable in form, pulvinate or effuse and indefinite in extent, normally superficial on bark or decorticated wood, $1.5\text{--}6.5 \times 1.8\text{--}30 \times 0.4\text{--}1.8$ mms. Ectostroma normally bright purple superficially, sometimes reddish brown to ochraceous. Interior of ectostroma non-refractive, always pale red to purple, sometimes scarlet, in longitudinal section; entostroma usually rather slight in quantity, differentiated from the tissue above, dark red to red-brown. Ectostroma sometimes breaking up into dull vinaceous particles in squash mounts. Perithecia usually evident in outline above the general level of the stroma, sometimes developing singly and far apart from each other within a thin or extensive stromal matrix but usually fairly close crowded when the stromata are pulvinate; globose to ovate, $150\text{--}550 \times 200\text{--}660\mu$; ostioles

PLATE VI Bottle cultures 2 months old, showing conidial development

1. *Hypoxylon croceum*
2. *Hypoxylon riograndense*
3. *Hypoxylon ferrugineum*
4. *Hypoxylon aureostroma*



umbilicate, usually distinct, with characteristic white periphysate mouths in pulvinate stromata. Asci cylindric, $75-170 \times 5-8\mu$; stipes $18-102\mu$. Spores gibbous, navicular or slightly crescentic, light or medium brown and subhyaline, rarely dark brown and opaque, $3.5-7.0 \times 8.0-14.0\mu$, ave. $5.4 \times 10.5\mu$.

South African Hosts: Probably comprise a wide range, including *Acacia mollissima*, *Olea capensis*, *Populus canadensis*, *Scutia myrtina*, *Sideroxylon inerme*.

Material examined:

A wide range of material in the herbaria cited.

Martin 5, 6, 69, 86, 124, 148, 317, 318, 328, 339, 388, 420, 421, 437, 468, 474, 479, 485, 500, 501, 502, 505, 1005, 1007, 1020, 1192; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1959, 1962). Martin 392, 580; Fernkloof, Grahamstown, E. Cape, South Africa, (1958, 1960). Martin 538, 564, 566; Highlands mtn., nr. Grahams-town, E. Cape, South Africa, (1959). Martin 541, 542, 545, 553; Hogsback, nr. Alice, E. Cape, South Africa, (1959). Martin 637, ex C. Booth (CMI), on *Albizia zygia*, Kori, Sierra Leone, (1961). Martin 641; ex Lowy, Baton Rouge, La., U.S.A., (1961). Martin 710, 727; Klamath National Forest, N. Calif., U.S.A. (1961). Martin 801, 802, 854; Arcata, N. Calif., U.S.A., (1961). Martin 903; ex Hennebert, Ontario, Canada, (1961). Martin 1077, 1078, 1101, 1102; Columbia, Mo., U.S.A. (1962). Martin 1115, 1121, 1148; Lake Ozark, Mo., U.S.A., (1962). Martin 1609; Stoneybrook, Rockland Co., N.Y., U.S.A. (1963). Martin 1703; Mt. Toby State Forest, Mass., U.S.A. (1963). Martin 1717; Savoy State Forest, Mass., U.S.A., (1963).

Cultural characters (Plate III: 1-2, 17-20; Plate V: 6)

Colonies velvety to velvet-felty, somewhat floccose when young, with raised central area. Surface characteristically fine, in contrast to *H. fuscum*, colour pink to saffron yellow, reddish or ochraceous, rarely dull white, with considerable variation in the same strains demonstrated by growth of monospore and multispore cultures. Normally colouration develops directly or soon after inoculation, especially in bottle culture, forming a large central blaze or halo round the centre, reaching maximum intensity after 14 days and then gradually fading. At maturity the outer part of the colony typically shows many small soft mycelial aggregates. Margin distinct, submersed, 3-13 mm wide; peripheral hyphae lying together. Conidia not produced in plate culture but evident in bottles after 4-8 weeks in various degrees of profusion, usually sparse and inconspicuous, orange brown. Stain variable, absent entirely or produced after 3 days, roseate orange, dull olive brown, or rarely olive green, diffusing up to but not beyond the margin and deepening with age. Growth on other media similar; that on Czapek tending to develop radiating furrows, accompanied by very intense hue of stain. Growth rate moderate, 2-4-2.9 mm/day at 25°C.

Microscopic characters (Fig. II: 3):

Primary mycelium undiagnostic, maximum diameter of the marginal hyphae $= 2.3\mu$. Secondary mycelium reticulate, loosely or closely anastomosed, with frequent branching, hyphae 1.8-3.7 diameter.

Conidiophores and conidia:

Conidiophores only distinct from the vegetative mycelium by the shorter ultimate branches, variable in length, $70-500 \times 1.2-3.1\mu$, unbranched or branched up to the second degree over the terminal parts or upper halves of the main axes; branching usually dichotomous and rarely ternate, in contrast to *H. fuscum*; fertile branches lying freely, unspecialized, $12-63 \times 1.4-2.5\mu$. Conidia acrogenous in clusters of 4-6, sessile, pyriform to napiform or clavate, $1.8-3.1 \times 3.7-5.6\mu$, ave. $2.3 \times 4.8\mu$.

This species is separable only from *H. fuscum* and *H. vogesiacum* on a combination of characters, chiefly the ascospore colour and size, and the simple type of conidiophore.

10. *Hypoxylon rubiginosum* forma *trichocladi* Martin. (Plate II: 6)

Stromata crustose, aplanate effuse, rather thin, $3-16 \times 5-6 \times 0.5-0.6$ mm, partly embedded in bark though still superficial. Surface of stroma deep purple, interior deep red, entostroma dark brown, well differentiated. Perithecia evident in outline, vertices flattened, $200-250 \times 450-550\mu$; ostioles conspicuously umbilicate with tufts of white periphyses, asci cylindric, nearly sessile, $90-125 \times 7-8\mu$; stipes $15-35\mu$. Spores oval-elliptic, equilateral, navicular or slightly concave, dark grey to black, $4.5-7.5 \times 9.0-13.5\mu$ ave. $6.2 \times 11.8\mu$.

South African Hosts: Trichocladus crinitus, Trichocladus ellipticus.

Material examined:

Martin 373, 374, 467, 549; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1959).

This might be regarded as a separate species were it not that *H. rubiginosum* material was observed on the same substrate showing gradations from the striking purple colour and crustose shape of this form to the normal. Material sent to the C.M.I. was identified as *H. haematostroma*, but it is distinct both on stromal and cultural grounds.

Cultural characters (Plate III: 24):

Colonies velvet-felty, dense and opaque, rarely subhyaline with smooth surface, dull white, sometimes tinted pale red. Saltants of much less luxuriant type frequently occur, suggesting genetic instability. Mycelial aggregates absent. Margin distinct, submersed, 2 mm. broad; peripheral hyphae compact. Stain red to red-black, characteristically irregular in formation, either in large semi-circular areas concentrically arranged around the colony centre, or in small flecks, or rarely diffuse and evenly spread. Growth slow, 1.4 mm/day at 25°C.

Microscopic characters (Fig. II: 14):

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 2.7μ . Secondary mycelium branched, ropy, $1.9-3.6\mu$ diam.

Conidiophores and conidia:

Sterile. This unfortunately makes final diagnosis rather arbitrary. On the whole this type shows the greatest general similarity is to *H. rubiginosum*, so it may be regarded as an unstable variant, whose expression in nature is favoured by growth on a particular host.

11. *Hypoxylon sphaeriosporum* Martin nov. sp. (Fig. I: 1, Plate I: 3, Plate II: 5)

Stromata rubra aut purpura; ab *Hypoxylon rubiginosum* differtur sporis latis vel suglobosis, $4.5-12.0 \times 7.5-18.0\mu$, medius $8.0 \times 13.2\mu$.

Stromata effuse, pulvinate or aplanate, orbicular or irregular in form, sometimes rather thin, superficial on bark or wood, $0.7 \times 8.7 \times 0.8-23 \times 0.3-0.8$ mm. Surface of stroma smooth or wrinkled, deep purple to maroon, interior olive green to black, concolorous, undifferentiated. Perithecia entirely evident to immersed entirely, globose rather small, $130-450 \times 250-450\mu$. Ostioles not distinguishable, at stroma level. Asci cylindric, $60-124 \times 7-14\mu$; stipes short, $15-48\mu$. Spores oval to subglobose, equilateral, sometimes mucronate, dark brown to black, variable in size, $4.5-12.0 \times 7.5-18.0\mu$, ave. $8.0 \times 13.2\mu$.

*South African Hosts: Passerina falcifolia.**Material examined:*

Martin 68, 110, 555; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1959). Martin 1791 ex Carroll 169; Dominical, Costa Rica, (1962).

Cultural characters (Plate III: 3, Plate IV: 12):

Colonies velvety, opaque, gleaming white, with a coarse surface. Margin distinct, 3—5 mm. broad, peripheral hyphae lying together. Stain none. Growth rate moderately fast, 3.7 mm/day at 25°C.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae = 2.3μ . Secondary mycelium reticulate, forming a close net-work; hyphae $2.0-2.8\mu$ in diameter.

Conidiophores and conidia: Sterile.

This strain like the previous one is hard to classify. The writer has given it specific rank on the grounds of superficial stromal differences from *H. rubiginosum*, the subglobose dark coloured spores, and its occurrence in more than one geographic area.

12. *Hypoxylon vogesiacum* Pers. ex Sacc. (Plate II: 8)

Currey F. Trans. Linn. Soc. Lond. **22**, 269, (1859). Miller J. H. Mycologia **25**, 325-326, (1933); Monog. Univ. Puerto Rico **B**, **2**, 207, (1934); World Species of *Hypoxylon*, **34**, (1961).

sub *Sphaeria vogesiaca* Pers. ex Sacc.

Persoon C. H. in Litt. Moug. et Nestl: Stirp. Vog.-Rhen. no. 765, (1823).

Stromata aplanopulvinate, forming small glomerules on bark 3—8 mm. diameter, or irregularly effused on bark and decorticated wood, $1.5\text{--}33 \times 3.0\text{--}49 \times 0.5\text{--}1.2$ mm. Surface of ectostroma usually light purple red to pink, sometimes maroon purple or reddish brown, smooth or wrinkled. Interior of stroma little differentiated, dark brown to ochraceous; ectostroma containing dull red particles. Perithecia evident at the vertices to completely immersed, oval, $300\text{--}700 \times 300\text{--}800\mu$; ostioles sometimes not visible, raised though indistinct, or normally umbilicate as white dots on the stromal surface. Asci cylindric, $100\text{--}230 \times 6\text{--}14\mu$; stipes $22\text{--}127\mu$. Spores equilateral, gibbous or navicular, dark brown, $3.5\text{--}10.0 \times 9.5\text{--}20.5\mu$, ave. $6.6 \times 13.6\mu$.

South African Hosts: Olea capensis, wood and bark.

Material examined:

Arnold; on *Fraxinus*, Gatineau Park, Quebec, Canada, (1957). (Mill.). Brown in Kauffmann 505 and Miller 4633; Takilma, Ore., U.S.A., (Mill.). Farlow in Miller 4620, 4627, 4628; on *Carpinus*, Shellburne, N. H., U.S.A. (1891, 1899), (Mill.). Martin 2, 3, 7, 8, 74, 144, 312, 341, 399, 453, 488, 998, 999, 1002, 1006, 1009, 1010, 1032, 1034, 1041; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1959). Martin 574; Highlands Mtn. nr. Grahamstown, Eastern Cape, South Africa (1959).

Cultural characters (Fig. II: 4; Plate III: 5, 21):

Colonies at first closely appressed with scant subhyaline dull yellow aerial mycelium, later becoming thin velvety and nearly opaque. Colour of the mycelium becomes deep ochre with age. Surface characteristically coarse, often uneven. Margin entire, not distinct; peripheral hyphae lying together, conidia appearing after 14 days, dull red with a greenish tint, not conspicuous though profuse. Stain at first orange to orange yellow to roseate orange, very diffuse, later deepening to dark ochre yellow or coffee brown. Growth moderate, 2.4 mm/day at 25°C .

Microscopic characters (Fig. II: 13):

Primary mycelium undiagnostic. Maximum diameter of the marginal hyphae = 2.3μ . Secondary mycelium loosely organized, of long lax hyphae $3.4\text{--}5.1\mu$ diam.

Conidiophores and conidia:

Conidiophores distinct from the vegetative mycelium due to the shorter branches, $100\text{--}200 \times 1.6\text{--}1.9\mu$, branched dichotomously or ternately to the second degree over the upper halves of the main axes. Fertile branches lying freely, $9\text{--}30 \times 1.2\text{--}2.5\mu$, typically mallet—or skittle-shaped with swollen, rounded or truncate apices.

Conidia borne in small apical clusters of 5—8, sessile, oval to globose, rarely somewhat pyriform, hyaline with a faint reddish tint when examined singly but collectively red-orange, $1.4\text{--}3.1 \times 3.1\text{--}4.6\mu$, ave. $2.3 \times 3.7\mu$.

This species is perhaps the most difficult to differentiate clearly from others with a reddish or purple stroma surface. Intergrades have been found by the writer whose stromal characters merge imperceptibly into *H. fuscum* or *H. rubrostromaticum*, both in this country and in North America. Culturally, however, the South African material was sharply distinct. Stromata of doubtful taxonomic position collected from California invariably yielded colonies agreeing with *H. fuscum* and were eventually assigned to that species. The writer therefore tends to base his concept of *H. vogesiacum* on South African material.

13. *Hypoxylon fuscum* Pers. ex Fr. (Fig. I: 2; Plate I: 1, 4, 9; Plate II: 10)

- Berkeley M. J. in J. E. Smith's English Flora 237, (1836); Grevillea 4, 49, (1875). Berlèse A. N. Fungi moricologiae VI, 2, (1889). Berlèse A. N. & G. Bresadola Ann. Soc. Alp. Trid., 21, (1887-1888). Bizzozero G. Flora Venet. critt. 1, 200, (1885). Brefeld O. Untersuchungen aus dem Gesamtgebiete der Mykologie X. Ascomyceten 2, 259, (1891). Bresadola G. & P. A. Saccardo. Malpighia 11, 294, (1897). Cooke M. C. Handbook of British Fungi II, 796, (1871); Ann N.Y. Acad. Sci. 1, 184, (1878); Handbook of Australian Fungi 293, (1892). Cornu M. Ann. Sci. Nat. Bot. 6, 85-86, (1876). Currey F. Trans. Linn. Soc. Lond. 22, 266, (1859). Dennis R. W. G. British Cup Fungi 178, (1960). Durieu de Maisonneuve M. & J. F. C. Montagne Explor. Alger. 1, 452, (1846). Ellis J. B. & B. M. Everhart Jour. Mycol. 4, 41, (1888); N. Amer. Pyren. 633, (1892). Fries E. M. Elenchus Fungorum II, 63, (1823). Fuckel L. Symbolae Mycologicae 234, (1869-1870). Gray S. F. Natural Arrangement of British Plants 1, 513, (1821). Greville R. K. Flora edinensis 356, (1824). Hennings P. Monsumia 1, 168, (1900); Hedwigia 42, (82), (1903). Hooker W. J. Flora Scotia II, 5, (1821). Jaczewski A. L. Bull. Soc. Myc. de France 11, 123, (1895). Karsten P. A. Mycologia Fennica II Pyrenomycetes, 39, (1873). Kickx J. Flore Crypt. Flanders 307, (1867). Lambotte E. Flore Myc. Belge 420, (1880). Lindau G. in Engler & Prantl's Die Natürlichen Pflanzenfamilien I, 484-485, (1897). Miller J. H. Trans. Brit. Mycol. Soc. 15, 147, (1930); World Species of Hypoxylon 18, (1961). Nitschke T. Pyren. Germ. 1, 35, (1867). Owens C. E. Proc. Indiana Acad. Sci. 1911, 304, (1912). Persoon, C. H. Syn. Meth. Fung., 12, (1801-1808). Quélet L. Champ. Jura et Voges III, 492, (1875). Rabenhorst G. L. Deutsch. Krypt. Flor. I, 221 (1844). Rabenhorst L. Kryptflor Deutsch. II, 861, (1887). Rehm. H. Berichte Naturh. ver. Augs. 26, 56, (1881); Ascomycetes Lojkani 33, (1882). Saccardo P. D. Fungi Ital. 569, (1877-1886). Schroter J. in Cohn's Kryptflor. Schlesien 463, (1908). Starback K. Bih. Svenska Vet-akad. Handl. 15, 8, (1889). Sydow H. & F. Petrak Ann. Mycol. 20, 184, (1922). Traverso J. B. Flora Ital. Crypt. I, 44, (1906).
- sub *Hypoxylon pruinatoides* Kauffm.
Kauffmann C. H. Pap. Mich. Acad. Sci. Arts & Letters 11, 169, (1930).
- sub *Hypoxylon rubiginosum* Pers. ex Fr. var. *tropica* Mill. Miller J. H.; World Species of Hypoxylon 31, (1961).
- sub *Sphaeria fusca* Pers.
Albertini J. D. & L. D. de Schweinitz Conspect. Fung. 4, (1805). Fries E. M. Systema Mycologicum 332, (1823).

Stromata pulvinate to aplanopulvinate, or irregularly effuse, especially when on decorticated wood, $0.5-11.2 \times 0.5-65 \times 0.3-2.5$ mms. Surface of stroma varying from reddish brown, red-purple to maroon or occasionally violaceous grey, and sometimes bearing superficial granulate ectostromal particles visible in longitudinal section. Interior of stroma usually differentiated, with the ectostroma lighter in hue than the darker purplish black entostroma. The ectostroma separates into purple black, deep red or vinaceous particles when squash mounts of the stromata are made, but these particles as in *H. rubiginosum* are never bright or conspicuous. Perithecia immersed or evident in outline, occasionally

evident to base, ovate, $200-500 \times 300-700\mu$; ostioles umbilicate, at level with the stromal surface, usually but not always conspicuous. Asci clavate or cylindrical, $90-240 \times 6-12\mu$; stipes $24-135\mu$. Spores oval elliptic, gibbous to navicular, medium to dark brown, $4.5-10.5 \times 10.0-28.0\mu$, ave. $6.6 \times 14.3\mu$.

South African hosts: Curtisea faginea, Rhus legati.

Material examined:

sub *Hypoxylon fuscopurpureum*

Brown; on *Amelanchier florida*, Siskiyou National forest, Takilma, Oregon, U.S.A., (1925), (AA). Dearness; on *Fraxinus*, London, Ont., Canada, (1904), (AA). Dearness; on *Ostrya virginica*, London, Ont., Canada (1904) (AA). Kauffmann; on *Liriodendron tulipifera*, Glen Echo, Md., U.S.A., (1918), (AA). Kauffmann; on *Umbellularia californica*, Siskiyou National forest, Takilma, Ore., U.S.A., (1925), (AA). Kauffmann; Rock River Mich. U.S.A., (1927), (AA). Parks 7542, 7545; on *Garrya elliptica*, Spruce Cove, Trinidad, Northern California, U.S.A., (1925), (AA).

sub *Hypoxylon fuscum*

A large quantity of material in the herbaria cited.

Martin 93, 298, 378, 411, 489, 516, 559; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1959). Martin 692, 693, 694, 704, 705, 706, 711, 712, 720, 721, 722, 723, 726; Klamath National forest, Klamath, N. Calif., U.S.A., (1961). Martin 777, 778, 779; O'Brien, Shasta County, N. Calif., U.S.A., (1961). Martin 790, 810, 817, 819, 821, 825, 829, 830, 848, 849, 850, 851, 855; Arcata, N. Calif., U.S.A., (1961). Martin 892; culture only, ex Centraal bureau voor Schimmelcultures, Baarn, (1961). Martin 898; ex C. Booth (CMI), Surrey, England, (1961).

sub *Hypoxylon oregonense*

Brown (det. Kauffmann); On *Amelanchier florida*, Takilma, Oregon, U.S.A., (1925), (AA).

sub *Hypoxylon pruinosoides*

Brown (det. Kauffmann); on *Corylus californica*, Takilma, Ore., U.S.A., (1925), (AA).

sub *Hypoxylon rubiginosum*

Kauffmann & Mains; Lake Placid, N.Y., U.S.A., (1914), (AA). Wehmeyer; on *Betula*, Elkmont, Tenn., U.S.A., (1924), (AA).

sub *Hypoxylon vogesiacum*

Brown; on *Acer circinatum*, Siskiyou National forest, Takilma, Ore., U.S.A., (1925), (AA). Kauffmann in Miller 4653; on *Salix*, Medicine Mtns., Wyo., U.S.A., (Mill.). Kauffmann & Brown; on *Athus*, Quiniault, Wash., U.S.A. (1925), (AA). Kauffmann & Wehmeyer; Mt. Hood, Ore., U.S.A., (1922), (AA).

Cultural characters (Plate III: 6-7; Plate IV: 11, 13; Plate V: 10):

Colonies velvet to velvet-felty, sometimes somewhat cottony or floccose, usually with a coarse texture developing at least with age, pure or dull white, partly discoloured amber, cream or dull yellow. Margin not distinct, peripheral hyphae compact. Conidia rarely produced immediately, usually developed with age, and sometimes absent entirely; forming a thin fawn or dull orange brown crust. Stain dark red, reddish orange or roseate, produced up to the margin and deepening in intensity towards the centre, rarely amber or ochraceous or absent. Growth slow to moderate, $0.3-3.6$ mms/day at 25°C .

Microscopic characters:

Primary mycelium undiagnostic. Maximum diameter of the marginal hyphae = 2.7μ diameter; in most species the range extends through $1.2-1.8\mu$. Secondary mycelium often absent; when developed it is uniform, ropy or reticulate, $1.5-5.6\mu$ in diameter.

Imperfect Stage: (Fig. II: 7; Plate IX: 1-4)

Brefeld O. Untersuchungen aus dem Gesamt. Myk X. Ascomyceten 2, 259, (1891).
 Jaczewski A. L. Bull. Soc. Myc. de Fr. 11, 123, (1895). Lindau G. in Engler & Prantl:
 Die Natürlichen Pflanzenfamilien I, 484, (1897).

The conidiophores fall into three types, but there is no apparent correlation between them and character of either stroma or mycelial colony.

- I. The commonest type (*Sporothrix-Calcarisporium* I-II) is relatively short in comparison with that of previous species, $25-320 \times 1.2-2.3\mu$, unbranched or branched to a varying degree over the length of or only at the terminal portion of the main axes. Branching is dichotomous, ternate or quadrate; and fertile branches lie freely or in trident formation. Fertile branches are $8-96 \times 1.2-2.2\mu$, with unspecialized or distinct globose heads, and smooth walls. The conidia are acrogenous, or in fascicles from the fertile branches or in random groups off the hyphae, on slender or stout sterigmata, or sessile, clavate or elliptic, sometimes approaching pyriform, with narrow bases, fawn brown, red brown, rarely white en masse, $1.0-2.5 \times 3.2-7.0\mu$, ave. $2.0 \times 4.5\mu$.
- II. This type, (*Sporothrix-Calcarisporium* IV-V), differs from the main one in repeated verticillate branching. Conidiophores are $150-210 \times 1.5-1.8\mu$ with rather delicate fertile branches $13-41 \times 1.2-1.5\mu$, in trident formation. Conidia as above, on stout peg-like sterigmata, clavate, fawn brown, $1.2-2.2 \times 3.7-5.0\mu$, ave. $1.8 \times 3.5\mu$.
- III. This type intermediate between *Sporothrix* II and *Acrostaphylus*, is distinguished by the dull brown tint and warted walls of the conidiophores and has been found to develop late in association with (I). Conidiophores are $85-255 \times 1.2-4.3\mu$, stout, with fertile branches $12-28 \times 1.8-2.5\mu$ lying freely or in trident formation. Conidia as above, sessile, equilateral, often botuliform, thin walled, white, $2.5-3.1 \times 4.3-5.5\mu$, ave. $2.8 \times 4.9\mu$.

PLATE VII Microscopic characters.

- 1-2. *Hypoxyton oodes*
 1. *Sporothrix* type III, $\times 210$
 2. *Sporothrix* type II, $\times 210$. Inset: Details of spores, $\times 540$
3. *Sporothrix schenckii*, $\times 210$, for comparison
4. *Hypoxyton albstigmatosum*
- 5, 8. *Sporothrix* type II, $\times 210$. Inset: Details of spores, $\times 540$
5. *Hypoxyton subchlorinum*
 5. *Sporothrix* type I: conidia mainly in fascicles, $\times 210$
 8. *Sporothrix* type III: showing sympodial branching, $\times 210$
6. *Hypoxyton occidentale*
7. *Sporothrix* type II, $\times 210$
7. *Hypoxyton fragiforme*
7. *Sporothrix* type II, $\times 210$
- 9-10 Reticulate-tentacular secondary mycelium
 9. *Hypoxyton subchlorinum*
 10. *Hypoxyton howeanum*



14. *Hypoxylon rubrostromaticum* Miller. (Plate I: 4)

Miller J. H. World Species of *Hypoxylon* 24, (1961).

sub *Hypoxylon glomerulatum* Theiss.

Rick J. Broteria ser. bot. 25, 27, (1931). Theissen F. Ann. Mycol. 6, 345, (1908); Ibid 7, 145, (1909).

sub *Hypoxylon haematites* Lév. var *macrospora* Theiss.

Theissen F. Ann. Mycol. 6, 345, (1908); Ibid 7, 145, (1909).

Stromata aplanopulvinate, of varying extent, $1.5-21 \times 1.8-98 \times 0.6-1.4$ mms. Surface maroon purple or red purple; ectostroma brittle refractive, vinaceous to black at sight, yielding vinaceous particles in microscopic preparations; entostroma well developed, corky, dull brown to black. Perithecia adjacent, evident entirely to completely immersed, ovate, $200-700 \times 400-800\mu$; ostioles clearly umbilicate or not visible. Asci cylindric, $130-160 \times 12-14\mu$; stipes $42-60\mu$. Spores gibbous to navicular with narrow ends, enclosed in hyaline sheaths, dark brown to black, $5.5-10.5 \times 12.0-22.5\mu$, ave. $7.7 \times 17.5\mu$.

Material examined:

Chardon & Toro in Miller 4650; Los Morros, Aragua, Venezuela, (1932), (Mill.). Martin 1067, 1068, 1070; ex Schroeder, Linda S'Dia, Costa Rica, (1962). Martin 1191; Nature's Valley, Knysna District, Western Cape, South Africa, (1962). McKenzie; New Zealand, (1925), (Mill.). Miller 2738 ex Theissen; Sao Leopoldo, Brazil, (Mill.).

sub *Hypoxylon vogesiacum*

Kauffmann in Miller 4653; on *Salix*, Medicine Mtns., Wyo., U.S.A. (Mill.). Shear; on *Rubus jamaicensis*, Maunaloa, Hawaii, (NFC). Thaxter 6880; St. Anne's Valley, Port of Spain (NFC), Trinidad, (1912-1913), (Mill.).

Cultural characters (Plate IV: 9; Plate V: 11):

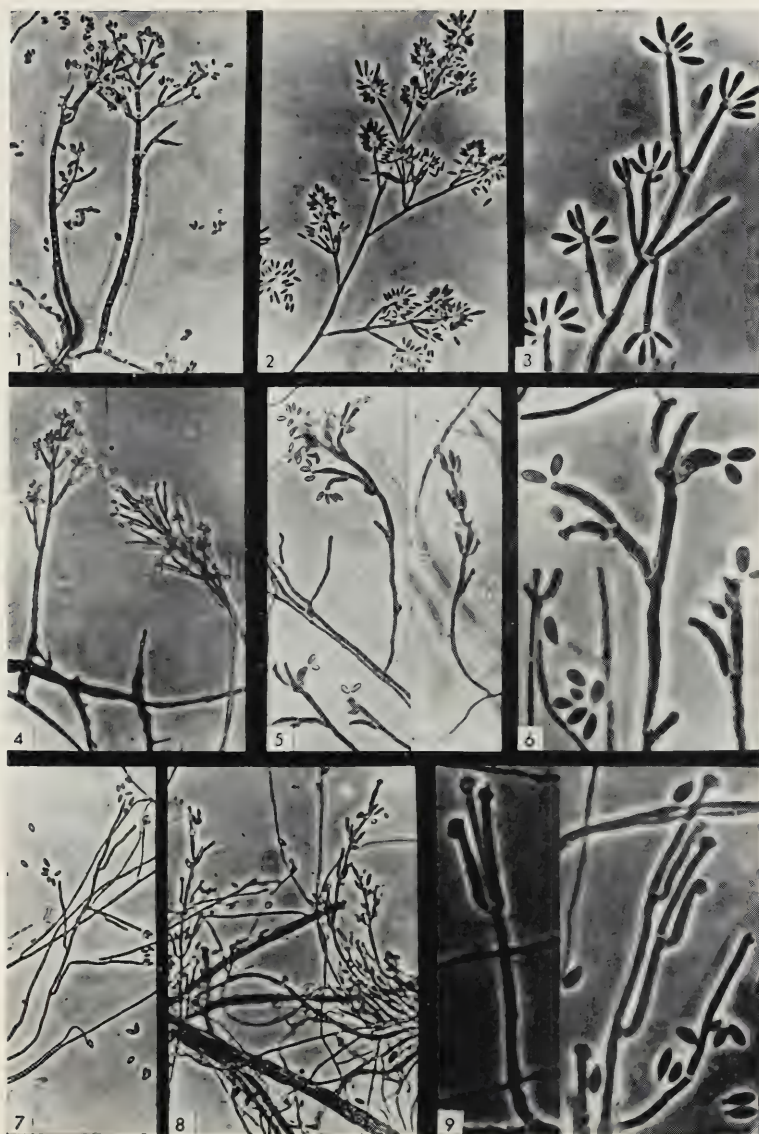
Colonies cottony to velvet felty, with coarse texture, pure white. Mycelial aggregates absent. Margin not distinct; hyphae lying together. Conidia formed by 7 days, but not conspicuous. Stain absent. Growth fast, $5.1-6.3$ mm/day at 25°C .

Microscopic characters (Plate IV: 5-6; Plate IX: 9):

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae = 2.3μ . Secondary mycelium absent.

PLATE VIII Microscopic characters (continued).

- 1—3. *Hypoxylon dieckmanni*
 1. Arborescent conidiophore with warted main axis (*Sporothrix* type IV), $\times 210$
 2. Upper part of dendroid conidiophore with smooth main axis, $\times 210$
 3. Details of above, $\times 540$
4. *Hypoxylon riograndense* (*Sporothrix* type IV), $\times 210$
- 5—6. *Hypoxylon rubrostromaticum*
 5. Dendroid and compact conidiophores (*Acrostaphylus*), $\times 210$
 6. Details of above, $\times 540$
- 7—9. *Hypoxylon bicolor*
 7. Conidiophores with dichotomous branching (*Sporothrix* type II), $\times 210$
 8. Conidiophores with verticils and tridents (*Sporothrix* types IV—V), also ropy secondary mycelium, $\times 210$
 9. Details of fertile branches, showing flaring heads, $\times 540$



Conidiophores and conidia:

Conidiophores distinct on account of their dark brown tint and warted walls, $100-500 \times 1.5-2.7\mu$, branched indefinitely over the supporting axes, with 2-3 branches at each junction. Fertile branches narrow or swollen, lying free or in trident formation, with unspecialized heads, $8-25 \times 1.2-3.1\mu$. Conidia acrogenous, sessile, clavate with broad bases, fawn en masse, $1.5-2.5 \times 3.7-5.0\mu$, ave. $2.1 \times 4.5\mu$. This type normally conforms to *Acrostaphylus* but may vary towards *Sporothrix* II.

The Hypomiltum Series

Hypoxylon hypomiltum has been doubtfully separated from *H. rubiginosum* by Miller (1961, p. 39) on account of a "blood-red subsurface". Miller's description, furthermore, refers to a fairly large effused species with conspicuous bright colouration. The writer has found that this covers only one of the many variants with brightly coloured stromata, and that there is a series leading from *H. rubiginosum*, beginning with forms that differ only in brighter subsurface colouration, to others with brighter superficial colouration and larger spore size. Some of these forms were originally merged with *H. rubiginosum* by Miller.

15. Hypoxylon bicolor E. & E. (Plate II: 11, 12)

Ellis J. B. & B. M. Everhart Jour Mycol 2, 88 (1886).

?sub *Hypoxylon ianthinum* Cke.

Cooke M. C. Grevillea 11, 132, (1883). Ellis J. B. & B. M. Everhart Jour. Mycol. 4, 89, (1887); N. Amer. Pyren. 650, (1892).

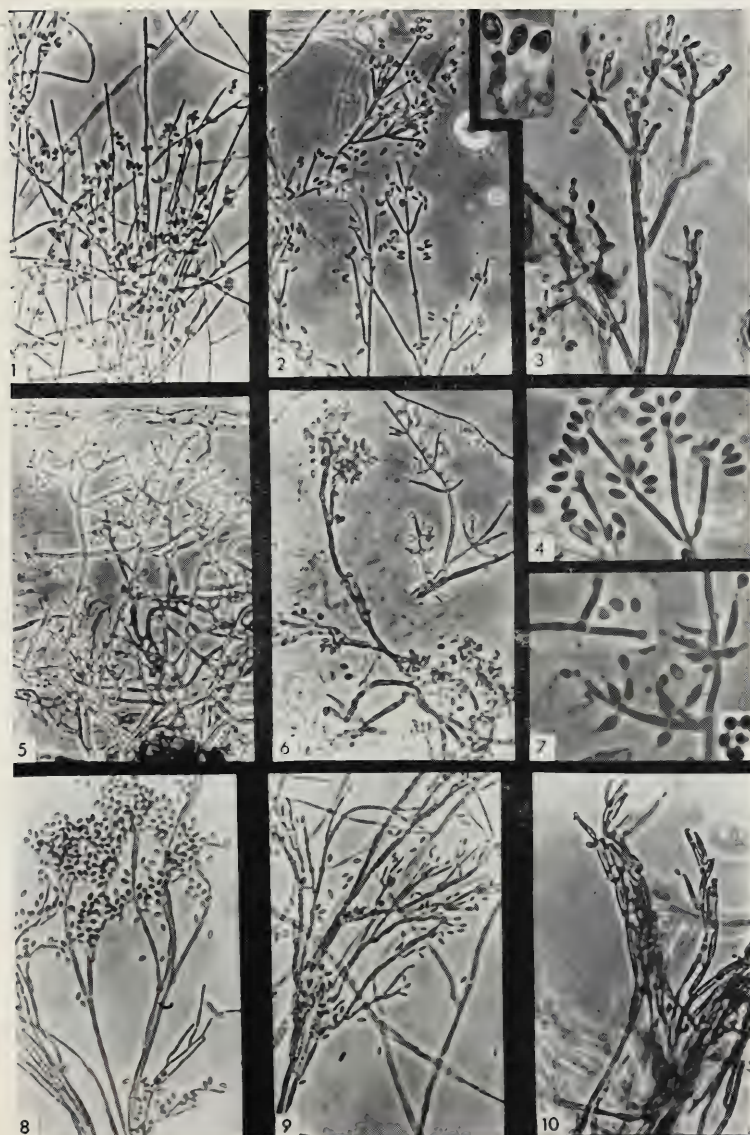
?sub *Nummularia ianthina* (Cke.) Lloyd

Lloyd C. G. Myc. Writ 7, 1312, (1924).

Stromata pulvinate or aplanopulvinate, superficial, varying in form, but never large and consistently effuse, $1.1-22 \times 1.7-87$ mms. Surface colouration light purple, ferruginous, ochraceous yellow, or white, frequently with a mixture of colours in the same stroma or set of stromata. The initial stage is yellow. Ectostroma usually brittle refractive when broken, disintegrating into

PLATE IX Microscopic characters (continued).

- 1-4. *Hypoxylon fuscum*: conidiophore types
 1. *Sporothrix* type I, with fascicles of conidia $\times 210$
 2. *Sporothrix* type IV, narrow verticillate $\times 210$
 3. *Sporothrix* type II stout, approaching *Acrostaphylus* $\times 210$
Inset: $\times 540$
 4. Details of (2): trident with fascicle of conidia $\times 540$
- 5-7. *Hypoxylon hypomiltum*
 5. Trichodermoid conidiophores (*Sporothrix* type V) $\times 210$
 6. *Sporothrix* type II $\times 210$ cf. (3) above
 7. Detail of fertile branches and conidia $\times 540$
- 8-10. Conidiophores intermediate between *Sporothrix* and *Acrostaphylus*
 8. *Hypoxylon croceopelum* $\times 210$
 9. *Hypoxylon rubrostromaticum* $\times 210$
 10. *Hypoxylon jecorinum* $\times 210$



yellow or orange particles in microscopic preparations. Entostroma well developed, dark coloured. Perithecia evident at vertices to completely immersed, usually fairly closely crowded, globose to ovate, $200\text{--}700 \times 200\text{--}1000\mu$; ostioles usually clearly umbilicate, sometimes not visible; periphyses rarely conspicuous at the ostiolar mouths. The stromal interior tends to disintegrate in tropical specimens leaving a hollow shell beneath the ostiolar mouths. Asci cylindric, $80\text{--}180 \times 5\text{--}8\mu$; stipes $27\text{--}112\mu$. Spores oval-elliptic, equilateral or navicular, light to dark brown, $3.5\text{--}7.5 \times 7.5\text{--}15.0\mu$, ave. $5.0 \times 10.2\mu$.

South African hosts: Canthium spinosum, Cassine croceum, Curtisia faginea, Passerina falcifolia.

Material examined:

sub *Hypoxylon bicolor*

Langlois; Nuttallburg, Va., U.S.A., (1893), (NYBG). Martin 222; Hogsback, nr. Alice, Eastern Cape, South Africa (1958). Martin 287, 325, 326, 330, 405, 469, 482, 492, 499, 562, 1042; Nature's Valley, Western Cape, South Africa, (1958, 1959, 1962). Martin 698, 729, 730, 731; Klamath, Northern California, U.S.A., (1961). Martin 772; O'Brien, Northern California, U.S.A., (1961). Martin 841, 842, 870, 874; Arcata, Northern California, U.S.A., (1961). Martin 905, 907, 908, 920-922, 924, 942, 944, 946; Mazatlán, Sinaloa, Mexico (1961). Martin 952, 955, 956, 957, 991, 1500, 1549; San Blás, Nayarit, Mexico (1961, 1962). Martin 1084, 1105; Columbia, Mo., U.S.A. (1962). Martin 1110, 1111-1114, 1116-1120, 1114, 1153, 1159, 1176; Lake Ozark, Mo., U.S.A., (1962). Martin 1633, 1638; Nyack Village, N.Y. State, U.S.A., (1963). Martin 1642; Lake Sebago, N.Y. State, U.S.A., (1963); Martin 1677, 1679, 1690-1694, 1736, 1737, 1741. Conway State Forest, Mass., U.S.A., (1963). Martin 1705; Mt. Toby, Mass., U.S.A., (1963). Martin 1725, 1729, 1732-1735; Savoy State Forest, Mass., U.S.A., (1963).

sub *Hypoxylon hypomiltum*

A wide range of material in the AA, CMI and other herbaria.

sub *Hypoxylon ianthinum*

Ellis 396; Clyde, N.Y. State, U.S.A., (1887), (NYBG). Ellis N. Amer. Fungi 1182, Bethel, Colo., U.S.A., (0000), (NYBG).

Cultural characters (Plate III: 8-10; Plate IV: 16, Plate V: 1-2):

Colonies velvety to felty, sometimes somewhat fleecy or cottony, of varying density, but with characteristically fine texture and smooth surface. Mycelial aggregates absent in contrast to *H. rubiginosum*. Colour of mycelium highly variable, basically pure or dull white but usually developing areas of brighter colour such as yellow, orange, or red-brown, from the centre outwards. Margin not distinct or forming a submersed zone 5-15 mm. wide, compact. Conidia sparsely developed, rusty red, occasionally dense and conspicuous, produced after 1 week or only with age. Stain variable, sometimes absent, normally some shade of reddish brown, more rarely amber, rose, reddish orange, dull buff brown or brandy colour. Appearance on other media essentially similar, but less luxuriant on maize and Czapek. Growth rate variable among strains, usually moderate, but varying from slow to fast, $1.7\text{--}6.8$ mm/day at 25°C .

Microscopic characters (Fig. II: 1):

Primary mycelium undiagnostic; max. diameter of marginal hyphae = 2.6μ .

Secondary mycelium sometimes absent; when present loosely organized to ropy, rarely reticulate, $1.5\text{--}4.5\mu$ diameter.

Conidiophores and conidia (Plate VIII: 7-9):

Conidiophores little differentiated to distinct, $9\text{--}1110 \times 1.5\text{--}3.1\mu$, unbranched to branched indefinitely over most or part of the main axes. Branching varies from dichotomous only to ternate or repeatedly verticillate, with the fertile branches lying freely or in trident formation. Fertile branches unspecialized or with distinct globose heads, $3.7\text{--}142 \times 1.2\text{--}2.5\mu$. Conidia clavate or pyriform, narrow based, sessile or on slender sterigmata, ochraceous, fawn brown, or ferruginous, $1.8\text{--}4.3 \times 3.1\text{--}7.5\mu$, ave. $2.4 \times 4.9\mu$. It is in the imperfect characters that this species shows the greatest difference from *H. rubiginosum*.

16. *Hypoxylon viridicolor* Martin, nov. sp.

Stromata aplanopulvinata, viridis; ab *Hypoxylon bicolor* differtur pigmento.

Stromata aplanopulvinate, of restricted extent, $2.3\text{--}5.0 \times 6.0\text{--}8.0 \times 0.7 \times 1.0$ mm. Surface of initial stage and ectostroma olive green; interior of ectostroma refractive, disintegrating into yellow green particles. Ectostroma and entostroma not sharply differentiated but the latter is darker. Perithecia vaguely evident, ovate, $500\text{--}700 \times 600\text{--}800\mu$, adjacent but not close crowded; ostioles not visible. Asci not seen. Spores navicular, with narrow ends, dark brown, $4.5\text{--}7.0 \times 9.5\text{--}15.0\mu$, ave. $5.1 \times 11.7\mu$.

South African hosts unidentifiable

Material examined:

Martin 487, Nature's Valley, Knysna District, Western Cape, South Africa, (1959).

Cultural characters (Plate IV: 14):

Colonies velvet and felty smooth, forming a thin mat with a rather coarse surface, aerial mycelium white to very pale grey and tinted pale reddish brown near the centre of the colony after 7 days, changing to reddish orange with age. Margin distinct, forming a wide submersed zone 12-13 mm, hyphae lying close together. Conidia formed with age, in fawn coloured irregular pulvinate masses scattered over the whole colony. Stain red brown becoming very conspicuous beneath the aerial mycelium and usually extending about 5 mm beyond the colony border. Appearance on Leonian's medium similar, but less luxuriant on maize, and on Czapek the colonies are furrowed, with orange yellow stain. Growth rate moderate, 2.0 mm/day at 25°C .

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae = 3.3μ . Secondary mycelium loose, $1.6\text{--}3.4\mu$ diam.

Conidiophores and conidia (Fig. II: 9):

The conidiophores are similar to those described under *H. fuscum*, type III, but are not warted and are dichotomously branched. They are broader than in other species of the *H. hypomiltum* series, with axes $2.3-3.9\mu$ in diameter, and are sometimes tinted amber, and the fertile branches narrow terminally to form peculiar hooked apices. The conidiophores are $150-200\mu$ long, branched over most of their length; fertile branches lying freely, narrowing distally, $10-60 \times 1.0-2.1\mu$. Conidia pleuracrogenous or acrogenous, sessile, oval-elliptic or clavate with narrow bases, reddish brown collectively, ave. $2.3-3.7 \times 4.0-7.4\mu$.

17. *Hypoxyton croceoplum* Berk. & Curt. (Plate II: 13, 14)

Berkeley M. J. *Grevillea* 4, 49, (1875). Ellis J. B. & B. M. Everhart *Jour. Mycol.* 4, 89, (1887); N. Amer. *Pyren.* 651, (1892). Miller J. H. *World Species of Hypoxyton* 37, (1961). Shear C. L. *Lloydia* 10, 60, (1947).

sub *Hypoxyton ochraceofulvum* Berk. & Cke.

Cooke M. C. *Grevillea* 11, 133, (1883).

sub *Hypoxyton polyporoideum* Cke.

Cooke M. C. *Grevillea* 12, 53, (1883).

sub *Hypoxyton pumilio* Sacc.

Saccardo P. A. *Jour. Mycol.* 12, 47, (1906).

Stromata normally pulvinate or glomeruliform, up to 5 mm diameter but also aplanopulvinate and effused, $0.9-2.5 \times 1.1-5.1 \times 0.5-1.6$ mms, superficial on bark or decorticated wood. Ectostromal surface dark red to purple red; interior scarlet refractive, displaying yellow and orange granules in microscopic mounts. Entostroma scanty, dark brown. In thin vertical section the stroma appears very pale red or pink and subhyaline when seen under the microscope, whereas sections of other species are more opaque. Perithecia are normally evident partially in outline, rather large and conspicuous, evident at the vertices, ovate to globose, $250-450-1000\mu$; ostioles clearly visible or indistinct. Asci clavate or cylindric, with stipes varying greatly in length within the same sample, $120-220 \times 8-10.5\mu$; stipes $50-120\mu$. Spores oval, navicular or crescentic, dark brown to black, $4.5-12.0 \times 10.0-27.0\mu$, ave. $6.6 \times 13.7\mu$.

South African hosts: Leucadendron adscendens, Passerina falcifolia, Populus canadensis, Pterocelastrus tricuspidatus, Virgilia oroboides.

This is possibly only a large-spored form of *H. bicolor*.

Material examined:

Kauffmann 504; Whitmore Lake, Mich., U.S.A., (1904), (AA). Kauffmann 508; on *Ulmus*, Stockbridge, Mich., U.S.A., (1928), (AA). Langlois 2154; St. Martinsville, La., U.S.A., (1889). (NYBG). Langlois 376; Pointe à la Hache, La., U.S.A., (1886), (NYBG). Martin 238; Hogsback, nr. Alice, Eastern Cape, South Africa, (1958). Martin 294, 319, 371, 383, 398; Nature's Valley, Knysna District, Western Cape, South Africa, (1958). Martin 583; Fern Kloof, Grahamstown, Eastern Cape, South Africa, (1958). Martin 1530, 1543, 1571; San Blas, Nayarit, Mexico, (1962).

Cultural characters (Plate III: 13; Plate IV: 17; Plate V: 8):

Colonies at first appressed, subhyaline, later dense velvet felty, white subhyaline tinted pale yellow to dull red. After 10–20 days colonies develop a pale yellow to dull red raised centre, a large pale reddish-grey intermediate zone of variable extent and a marginal zone 5–10 mm wide, submerged, colourless to white subhyaline; marginal hyphae lie close together. Eventually the centre turns dull red and secretes drops of deep red stain. Conidia are produced with age and are not conspicuous, dull red. Stain is dark red, very conspicuous, though not extending beyond the margin. Appearance on other media similar but not as luxuriant. Growth rate variable, slow to fast, 1.7–4.5 mm/day at 25°C.

Microscopic characters:

Primary mycelium undiagnostic, maximum diameter of marginal hyphae = 2.3μ . Secondary mycelium loose or reticulate, 1.9 – 6.0μ diam.

Conidiophores and conidia (Fig. II: 5; Plate IX: 8):

Conidiophores distinct, consisting of compact ramifying systems, 150–300 $\times$ 1.9–2.5 μ , colourless or tinted pink, and smooth or warted. Main axes are branched dichotomously or ternately to the second degree or indefinitely, over most of their length. Fertile branches lying freely or in trident formation, sometimes in repeated verticils, narrow with unmodified apices; 10–70 $\times$ 1.0–3.1 μ . Conidia acrogenous or pleuracrogenous, sessile, clavate with narrow bases, usually with bluntly pointed ends, pink or dull red *en masse*, 1.4–2.5 $\times$ 3.1–6.3 μ , ave. $2.1 \times 4.3\mu$. This species also shows the same variation towards *Acrostaphylus* as noted for *H. fuscum* and *H. hypomiltum*.

18. *Hypoxylon novemexicanum* Miller (Plate I: 5)

Miller J. H. *World Species of Hypoxylon* 57, (1961).

Stromata aplanopulvinate to very thinly effused, superficial on bark or decorticated wood, 1.5–5.5 $\times$ 2.0–22 $\times$ 0.6–1.5 mm. Surface of ectostroma smooth or minutely cracked, dull purple at maturity, rapidly darkening to black with age, characteristically overlaid with a persistent white granular or mealy covering. South African material was often shown to be infected with a parasite, *Calculosphaeria* sp. that formed protruding perithecia. Ectostroma and entostroma not clearly differentiated from each other, but dark brown to black in longitudinal section, with the former containing dull red orange particles. Perithecia entirely immersed, oval, sometimes polystichous, globose to flask shaped, 300–450 $\times$ 400–800 μ , reaching the surface by short ostiolar necks; ostioles are however not visible on the surface of the stroma. Asci not observed. Spores elliptic, usually strongly inequilateral, gibbous or with one side concave, dark chestnut brown, 5.0–9.5 $\times$ 12.5–19.5 μ , ave. $7.7 \times 16.2\mu$.

South African hosts: unidentifiable.

Material examined:

Miller 58961; Cloudcroft, New Mexico, U.S.A., (1904), (Mill.). Martin 15, 41, 292, 1001, 1021, 1022, 1038; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1962), Martin 221; Hogsback, nr. Alice, Eastern Cape, South Africa, (1958).

Cultural characters (Plate III: 11-12, Plate IV: 8):

Colonies thin or densely velvety, smooth, subhyaline to opaque; colour of aerial mycelium variable, basically white but usually tinged yellow or buff. Usually the centre of the colony is raised above the general level. Margin distinct, compact, forming a broad zone of submerged appressed white subhyaline mycelium 4 mm wide. Conidia are sparse, inconspicuous, dull brown, produced after 2 months. Stain at first roseate orange or brandy colour; then deepening to red brown, becoming finally black; very conspicuous through the colony and extending beyond the margin; stain also secreted as amber or roseate drops on the surface of the colony. Plate cultures on maize and Czapek show less luxuriance of growth. Growth slow, 1.6 mm/day at 25°C.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae = 1.7μ . Secondary mycelium consists of long, sparingly branched, loosely associated stout hyphae $3.5-5.0\mu$ diam.

Conidiophores and conidia (Fig. II: 11):

Conidiophores distinct from the vegetative mycelium by the type of branching and shorter length of the branches, $110-130 \times 1.2-1.8\mu$, dichotomously or ternately branched; fertile branches often in trident formation, $13-50 \times 1.0-1.7\mu$, usually with broad recurved apices. Conidia borne in apical clusters, oval to oval-elliptic, equilateral, dull brown collectively, $1.4-3.1 \times 3.1-5.4\mu$, ave. $1.9 \times 4.0\mu$.

19. *Hypoxylon albstigmatosum* Spegazzini. (Plate I: 3)

sub *Hypoxylon albstigmatosum* Speg.

Spegazzini C. Anal. Soc. Cient. Arg. 18, 271, (1884).

sub *Hypoxylon guarapiense* Speg.

Spegazzini C. Anal. Soc. Cient Arg. 18 272, (1884).

Stromata pulvinate or aplanopulvinate, superficial on decorticated wood and bark, $1.4-16.5 \times 1.5-78 \times 0.7-1.5$ mms. Surface of stroma smooth or wrinkled, red brown or red purple as in *H. rubiginosum* but more intense in hue; interior tending to disintegrate rapidly after maturity, differentiated into a reddish brown to orange ectostroma and dark reddish-black entostroma; ectostroma refractive, unlike *H. rubiginosum*, separating into orange, yellow or vinaceous particles in squash mounts. Perithecia usually vaguely evident or immersed, rarely with prominent vertices, adjacent or in palisade formation,

ovate, $300\text{--}500 \times 400\text{--}700\mu$; ostioles sometimes not visible, commonly umbilicate but not as conspicuous as in *H. rubiginosum*. Asci cylindric, $120\text{--}145 \times 7\text{--}9\mu$; stipes $48\text{--}60\mu$. Spores gibbous to navicular, dark brown to black, $4.5\text{--}9.0 \times 9.5\text{--}14.5\mu$, ave. $5.3 \times 10.7\mu$. The spore colour also differentiates the species from *H. rubiginosum*.

Material examined:

sub *Hypoxylon albstigmatosum*

Balansa 2781; Guarapi, Paraguay, (1878), (NYBG). Martin 911-919, 925, 930, 941, 943, 945; Mazatlán, Sinaloa, Mexico, (1961). Martin 951, 958, 960-962, 1525, San Blas, Nayarit, Mexico, (1961, 1962).

sub *Hypoxylon guarapiense*

Balansa 2764; Guarapi, Paraguay, (1878), (NYBG).

Cultural characters (Plate V: 13):

Colonies felty with fine or coarse texture, dull white, without mycelial aggregates. Margin not distinct, peripheral hyphae widely dispersed. Conidia produced almost immediately, forming a reddish brown or orange brown layer. Stain absent. Growth rapid, 6.0 mms/day at 25°C .

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae = 1.5μ . Secondary mycelium absent.

Conidiophores and conidia (Plate VII: 4):

Conidiophores variable, $70\text{--}525 \times 1.2\text{--}2.2\mu$, branched to the second degree dichotomously or ternately over the length or upper halves of the main axes. Fertile branches lying freely or in trident formation, $10\text{--}33 \times 1.2\text{--}2.7\mu$, with unspecialized or slightly swollen heads. Conidia acrogenous, sessile or on stout sterigmata, clavate to pyriform, red brown or orange brown, $1.8\text{--}3.1 \times 4.3\text{--}6.3\mu$, ave. $2.5 \times 5.5\mu$.

20. *Hypoxylon occidentale* Ellis and Morgan ex Martin (Plate I: 2, 8)

Stromata pulvinate or aplanate forming linear crusts; $2.5\text{--}53 \times 2.5\text{--}135 \times 0.5\text{--}2.0\text{ mm}$. Surface maroon purple or deep red, sometimes smooth, but typically granulate or verrucose. Subiculum present in some samples, of fine crustose hyphae, $1.2\text{--}3.1\mu$ diam. also purplish red or red brown. Ectostroma greenish yellow at sight or vinaceous, refractive, sometimes revealed by disintegration of the thin outer layer, and separating into vinaceous particles in squash mounts. Entostroma sharply differentiated, corky, dull brown or black. Perithecia evident at vertices to entirely immersed, $400\text{--}600 \times 500\text{--}900\mu$, close crowded in palisade formation, rarely simply adjacent; ostioles not visible at stromal level or raised slightly on prominences, rarely clearly umbilicate. Asci cylindric, $90\text{--}115 \times 5\text{--}8\mu$; stipes $30\text{--}45\mu$ long. Spores gibbous to navicular, dark brown, $4.5\text{--}6.5 \times 8.0\text{--}12.5\mu$, ave. $5.3 \times 10.6\mu$.

Material examined:

- sub *Hypoxylon dieckmanni*
Shear; Florida, U.S.A., (1939), (NYBG).
- sub *Hypoxylon glomeratum* and *H. investiens*
Ellis 1132; (details absent), U.S.A., (NYBG).
- sub *Hypoxylon occidentale*
Martin 738; O'Brien, N. Calif., U.S.A., (1961). Martin 808, 846, 847, 863-865, 886;
Arcata, N. Calif., U.S.A., (1961). Morgan 621; on *Liriodendron*, Ohio, U.S.A., (NYBG).
Ined?
- sub *Hypoxylon subchlorinum*
Langlois 1475; Pointe à la Hache, U.S.A., (1886), (NYBG).

Cultural characters:

Colonies sparse felty, with fine texture; margin not distinct, hyphae lying together. Colour at first dull white, becoming pink due to the rapid formation of conidia, always occurring under 7 days. Margin entire, compact. Stain usually roseate, sometimes ochraceous. Growth moderate, 2.5 mm/day at 25°C.

This species, *H. croceum* and *H. allostigmatosum* are analogous to *H. serpens* and other species of *Entoleuca* in colony development. (Martin 1968, p. 197).

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 2.2µ. Secondary mycelium loosely organized, hyphae 1.2—1.8µ in diameter.

Conidiophores and conidia (Plate VII: 6):

Conidiophores 285—360 × 1.8—2.3µ, little differentiated, unbranched to indefinitely branched over the upper halves or terminal parts of the main axes. Branching is dichotomous or ternate; fertile branches 15—28 × 1.8—2.3µ; lying freely, rarely in trident formation, usually with slightly swollen or distinctly globose apices. Conidia acrogenous or in fascicles up the fertile branches, on slender sterigmata, pyriform with narrow bases, pink collectively, 1.8—2.5 × 3.7—6.3µ, ave. 2.3 × 4.7µ.

21. *Hypoxylon subchlorinum* Ellis and Calkins

Ellis, J. B. & B. M. Everhart. Jour Mycol 4, 86 (1888).

Stromata similar to *H. occidentale* in broad respects but thinner and not as extensive, pulvinate to aplanate; 2.5—18 × 5.0—110 × 0.3—1.2 mm. Surface purple-red or reddish brown, but smooth, unlike *H. occidentale*; subiculum also present of the same colour. Ellis notes on the type material (Calkins, 1886) that the stroma was greenish-yellow inside; the present writer could not confirm this but frequently saw conspicuous yellow or orange particles in herbarium and collected material. Entostroma slight, dull brown to black. Perithecia evident at vertices to vaguely so, ovate, 150—600 × 200—900µ; close crowded in palisade formation; ostioles usually indistinct, sometimes raised on conic protuberances. Asci not seen, reported as cylindric, with the sporing part 60—65 × 7µ. Spores

gibbous to navicular, medium to dark brown, $3.5-7.0 \times 7.5-12.5\mu$, ave. $4.9 \times 10.3\mu$.

Material examined:

sub *Hypoxylon investiens*

Shear 5819; (details absent), (NYBG).

sub *Hypoxylon subchlorinum*

Calkins in Ellis & Everhart, N. Amer. Fungi 2115, Jacksonville, Fla., U.S.A., (1886), (AA), (NYBG). Kauffmann; Brooksville, Fla., U.S.A., (1919), (AA). Martin 1630-1632; Nyack village, Rockland Co., N.Y. State, U.S.A. (1963). Martin 1730; Savoy State Forest, Mass., U.S.A., (1963).

Cultural characters (Plate V: 5):

Colonies cottony, dull white, with fine or coarse texture; margin not distinct, with compact hyphae.

Mycelial aggregates present in moderate quantity. Conidia formed by 7 days but not conspicuous. Stain ochraceous. Growth rate moderate, 3.3 mm/day at 25°C.

Microscopic characters (Plate VII: 9):

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 1.2μ . Secondary mycelium reticulate-tentacular (cf. *H. howeianum*); hyphae $1.2-1.8\mu$ diam.

Conidiophores and conidia (Plate VII: 5, 8):

Conidiophores distinct from the vegetative mycelium on account of their sympodial development (cf. *H. aureostroma*), $2.0-660 \times 1.2\mu$; main axes unbranched or branched to the first degree.

The axes of the conidiophores are made up of successive fertile side branches, each of which terminates in a cluster of conidia. Fertile branches also bear fascicles of conidia off their sides, and vary greatly in length, $15-198 \times 1.2-1.8\mu$. The conidia are sessile, clavate with narrow bases, white, $1.8-2.5 \times 4.7-7.5\mu$, ave. $2.3 \times 5.7\mu$.

22. *Hypoxylon hypomiltum* Mont. (Plate II: 15)

Berkeley M. J. & C. E. Broome Jour. Linn. Soc. Lond. **14**, 121, (1875). Miller J. H. Bothalia **4**, 257, (1942); World Species of *Hypoxylon* 38, (1961). Montagne J. F. C. Ann. Sci. Nat. **11** 13, 7, 56, (1840); in Gray: Hist. Chile VII, 444, (1850); Syll. Crypt. 214, (1856). Petch T. Ann. roy. bot. gard. Perad, **8**, 156, (1924). Sydow H. & P. & E. J. Butler Ann. Mycol. **9**, 416, (1911).

sub *Hypoxylon fendleri* Berk. & Cke.

Cooke M. C. Grevillea **11**, 132, (1883). Ellis J. B. & B. M. Everhart Jour. Mycol. **4**, 87, (1887); N. Amer. Pyren 646, (1892).

sub *Hypoxylon subgilvum* Berk. & Br.

Berkeley M. J. & C. E. Broome Jour. Linn. Soc. Lond. **14**, 120, (1875). Petch T. Ann. roy. bot. gard. Perad. **8**, 157, (1924). Rick J. Brotéria bot. ser. **25**, 30, (1931).

Stromata aplanate to aplanopulvinate, usually covering large areas of wood and bark, $3-26 \times 3-43 \times 0.9-5.0$ mm, smooth, deep vivid lateritic orange to

brick red on sight. Ectostroma refractive with orange or yellow granulate particles; entostroma dark, corky. Perithecia with vertices evident or immersed, ovate, 300—500—1000 μ ; ostioles punctate umbilicate, and conspicuous or invisible. Asci cylindric, 105—130 $\times$ 5—6 μ ; stipes 50—60 μ . Spores elliptic, equilateral, gibbous or navicular, medium brown, 3.5—7.0 $\times$ 7.0—15.0 μ , ave. 4.7 $\times$ 9.8 μ .

South African hosts: Olea capensis.

Material examined:

- Brown, Britton & Seaver 1332 & 1411b; Bermuda, (1912), (NYBG). G. W. Martin & Welden 8330; Canal Zone, Corundu, Panama, (1952), (NYBG). Martin 490; Nature's Valley, Knysna Dist., Western Cape, South Africa (1959). Parks 22003; Rarotonga, Polynesia, (1929), (AA). Shear & Stevens, on *Manifera indica*; Oahu, Hawaii, (1928), (NYBG). Smith 31; Castillo, Nicaragua, (1893), (NYBG). Weir in USDA 6517, on *Dichrostachys nutans*: Trinidad, Cuba, (1924), (AA).
- sub *Hypoxyton perforatum*
Rick; Brazil, (1905) (AA).
- sub *Hypoxyton rubiginosum*
Fink; Manati, Puerto Rico, (1916), (AA). Miller in UGH 5832; Bobbin Mill, Athens, Ga., U.S.A., (1928), (AA).
- sub *Nummularia lateritia*
Ellis & Everhart N. Amer. Fungi 3033; (details incomplete), (NYBG).

Cultural characters (Plate IV: 15):

Colonies at first mainly canescent appressed, with a large marginal zone and centre with more developed mycelium, later velvety, opaque white with smooth fine surface. Margin distinct, submersed, 4 mm broad; hyphae close together. Conidia are developed with age, sparse, and rusty brown. Stain variable in time of appearance, but present before 1 month, deep mauve pink turning with age to rich orange red. Appearance on Leonian's agar similar, but less luxuriant on maize and Czapek. Growth rate moderate, 2.6 mm/day at 25°C.

Microscopic characters:

Primary mycelium undiagnostic; max. diameter of marginal hyphae = 3.0 μ . Secondary mycelium absent.

Conidiophores and conidia (Plate IX: 5-7):

Conidiophores determinate or forming an indefinitely ramifying system, 50—230 $\times$ 2.5—3.2 μ , strongly verticillate with verticils repeated several times up to the main axes. Fertile branches 2—5 at each verticil, 6.6—23 $\times$ 2.5—5.0 μ of two types: elongate with flaring heads and uniform in diameter, and swollen at the base with narrow heads and rather squat as in the genus *Trichoderma*. The latter are produced exclusively over the upper parts of the main axes. As the colony ages a second type of conidiophore develops (cf. *H. fuscum*) 110—230 $\times$ 3.3—5.3 μ with warted walls, pale brown tint and normal branches, intermediate between *Sporothrix* II and *Acrostaphylus*. Conidia oval to subglobose, often thick walled, 3.7—4.3 $\times$ 4.0—5.7 μ , ave. 4.0 $\times$ 4.5 μ .

23. *Hypoxylon haematostroma* Mont.

- Berkeley M. J. Jour. Linn. Soc. **10**, 384, (1869). Bresadola G. & P. A. Saccardo Malpighia **4**, 301, (1890). Ellis J. B. & B. M. Everhart Bull. Lab. Nat. Hist. Linn. Iowa **2**, 415, (1893). Lloyd C. G. Myc. Writ. **7**, 1284, (1924). Miller J. H. Linn. Puerto Rico B **2**, 201, (1934). Bothalia **4**, 257, (1942); World Species of *Hypoxylon* **36**, (1961). Montagne J. F. C. in Sagra: Hist. Cuba **344**, (1838-1842); Ann. Sci. Nat. II **17**, 124, (1842); Syll. Crypt. **215**, (1856). Parks H. E. Univ. Calif. Publ. Bot. **12**, 50, (1926). Rehm H. Leaf. Philipp. Bot. **6**, 1944, (1913); Ibid **8**, 2958, (1916). Rick J. Broteria ser. bot. **25**, 30 (1931). Theissen F. Ann. Mycol. **7**, 149, (1909).
- sub *Hypoxylon haematites* Lév. ex Cke, non Theissen.
Chardon C. E. Bol. R  al. Soc. Espana Hist. Nat. **28**, 121 (1928). Cooke M. C. Grevillea **11**, 133, (1883); Handbook of Australian fungi **294**, (1892). Rick J. Broteria ser. bot. **25**, 27, (1931). Theissen F. Ann. Mycol. **7**, 145, (1909).
- sub *Hypoxylon lucidum* E. & E.
Ellis J. B. & B. M. Everhart Bull. Lab. Nat. Hist. Linn. Iowa **4**, 72, (1896).
- sub *Hypoxylon ochraceum* Henn.
Hennings P. Hedwigia **36**, 228, (1897). Starb  ck H. Bih. Svensk. Vet.-akd. Handl. **27**, 9, (1901); Arkiv. fur bot **5**, 30, (1905).
- sub *Hypoxylon st. janianum* Ferd. & Winge
Ferdinandson G. & O. Winge Bot. Tidskrif **29**, 14, (1909).
- sub *Hypoxylon subrutileum* Starb  ck
Starb  ck K. Bih. Svensk vet.-akad Handl. **27**, 10, (1901).
- sub *Hypoxylon veracruceis* Berk. & Cke.
Cooke M. C. Grevillea **11**, 129, (1883). Ellis J. B. & B. M. Everhart Jour. Mycol. **4**, 40, (1888).
- sub *Hypoxylon vividum* Berk. & Br.
Berkeley M. J. & C. E. Broome Jour. Linn. Soc. **14**, 121 (1875). Petch T. Ann. roy. bot. gard. Perad. **8**, 154, (1924). Rick J. Broteria ser. Bot. **25**, 27, (1931). Theissen F. Ann. Mycol. **7**, 144, (1909); Ibid **9**, 159, (1911).

Stromata aplanopulvinate or pulvinate, 4—25 × 10—100 × 1.5—3.5 mm, with characteristic deep yellow to orange surface; subiculum sometimes present of closely anastomosed hyphae 1.2—2.5 μ diameter. Ectostroma refractive, orange red, separating into blood-red particles; entostroma dark coloured, well developed and corky. Perithecia evident at vertices or only vaguely so, elongate oval, 300—800 × 700 × 2000 μ ; ostioles typical umbilicate. The interior of the stroma including the perithecia tends to disintegrate with age, leaving a hollow shell. Asci cylindric, 110 × 150 × 9—10 μ . Spores gibbous to navicular with narrow ends, dark brown, 5.0—9.0 × 10.0—16.5 μ , ave. 6.8 × 13.4 μ .

Material examined:

Carroll 136; Payap, Thailand, (1958). G. W. Martin & Welden 8599; Barro Colorado Island, Panama, (1952), (NYBG). Martin 923; Mazatl  n, Sinaloa, Mexico, (1961). Martin 965, 966, 985, 994, 1503; San Bl  s, Nayarit, Mexico, (1961, 1962). Murrill 45; Florida, U.S.A., (1923), (NYBG). Thaxter 710; Coconut Grove, Fla., U.S.A., (1897-1898), (AA, NYBG). Weir; on *Ceiba*, Santo Domingo city, Dominica, (1926), (AA).

Cultural characters (Plate V: 14):

This species is perhaps the easiest of those in the *Euhypoxylon* group to recognize in culture. Colonies felty, dull white subhyaline, growing thinly with fine texture; soft mycelial aggregates present in moderate quantity, formed of conspicuous secondary mycelium; margin not distinct, hyphae lying close together. Conidia develop by 7 days, in conspicuous pink balls on short, robust

erect conidiophores. Stain absent. The peculiar growth form can be studied best by placing a disc of sterilized damp blotting paper upon the culture and allowing the mycelium to grow over the surface. Growth moderate, 3.0 mm/day at 25°C.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae = 1.8μ . Secondary mycelium characteristic for the species, vesiculate, bead-like, loose or closely anastomosed, $3.0\text{--}13.5\mu$ in diameter.

Conidiophores and conidia (Plate X: 4-6):

Conidiophores fairly short and distinctive, stout, smooth or warted, $90\text{--}125 \times 2.5\text{--}2.7\mu$, branched to the first or second degree over the upper parts or at the apices; 3-5 branches arising at a single point. Fertile branches narrow or swollen clavate as in species of *Nummulariola*, smooth, held in trident formation; heads unmodified; $22\text{--}30 \times 2.5\text{--}3.1\mu$. Conidia acrogenous, on slender sterigmata, broad ovate to napiform, pink *en masse*, $2.5\text{--}3.7 \times 5.0\text{--}6.3\mu$, ave. $3.1 \times 5.8\mu$.

24. *Hypoxyton jecorinum* Berk. & Rav.

- Berkeley M. J. *Grevillea* 4, 50, (1875). Ellis J. B. & Everhart B. M. *Jour. Mycol.* 4, 88, (1887); N. Amer. *Pyren.* 650, (1892). Miller J. H. *World Species of Hypoxyton* 39, (1961).
 sub *Hypoxyton erythrostroma* Mill.
 Miller J. H. *Mycologia* 25, 323, (1933).
 sub *Nummularia cinnabarina* Henn.
 Hennings P. *Hedwigia* 36, 227, (1897). Lloyd C. G. *Myc. Writ.* 7, 1130, (1922).

Stromata widely effused and aplanate, or aplanopulvinate and relatively small, $2.5\text{--}29 \times 3.0\text{--}100 \times 0.5\text{--}2.3\mu$, with orange or orange brown surface, and bright refractive orange red subsurface corresponding to the ectostroma that sometimes reaches below the perithecia. Entostroma dark and corky; sometimes scanty. Perithecia evident at vertices or immersed, elongate ovate, $200\text{--}500 \times 400\text{--}900\mu$; ostioles umbilicate. Asci cylindric, $60\text{--}90 \times 4\text{--}6\mu$; stipes $20\text{--}30\mu$. Spores oval gibbous, medium brown, $3.0\text{--}4.5\text{--}6.0\text{--}9.5\mu$, ave. $3.8 \times 7.5\mu$.

PLATE X Microscopic characters concluded.

- 1-3. *Hypoxyton sclerophaeum* (*Acrostaphylus*)
 1. Coremium associated with stromata $\times 210$
 2. Arborescent and dendroid conidiophores $\times 210$
 3. Detail of fertile branches and conidia $\times 540$
 4-6. *Hypoxyton haematostroma* (*Acrostaphylus*)
 4. Vesiculate secondary mycelium $\times 210$
 5. Conidiophores $\times 210$
 6. Detail of fertile branches and conidia $\times 540$
 7-9. Coremia associated with stromata
 7. *Hypoxyton fragiforme* $\times 55$
 8. Detail of (7) showing tightly woven central core, $\times 210$
 9. *Hypoxyton oodes*: centre more diffuse, $\times 210$



This species appears to be a small-spored form of *H. haematostroma*, but further investigation is necessary to make a definite statement.

Material examined:

Murrill 104; Royal Palm Hammock, Fla., U.S.A., (1923), (NYBG). Shear; Matheson Hammock, Wade Co., Fla., U.S.A., (1940), (NYBG). Thaxter 6947; St. Ann's Valley, Port of Spain, Trinidad, (1912-1913), (NYBG).

Cultural characters (Plate IX: 10):

No material was available for culture.

Conidiophores and conidia:

Conidiophores associated with stromatic material cited above (Shear, 1940) showed some resemblance to those described for *H. viridicolor*, being intermediate between *Sporothrix* and *Acrostaphylus*. They were $190-230 \times 2.3-5.0\mu$, dichotomously branched over most of the main axes. Fertile branches lying free or in trident formation, occasionally 3 at a node, unspecialized or with hooked apices, $18-50 \times 2.3-3.7\mu$. Conidia oval to subglobose, reddish *en masse* $3.7-5.0 \times 3.2-6.7\mu$, ave. $4.2 \times 5.3\mu$.

This type resembles that described for *H. viridicolor* and is intermediate between *Sporothrix* II and *Acrostaphylus*.

The remaining species of the Hypomiltum series, *H. argillaceum* and *H. rutilum*, were not available for culture.

The Fragiforme Series

The members of this group bear some resemblance to those of the genus *Daldinia* to be treated in a later paper.

25. Hypoxylon fragiforme (Pers. ex Fr.) Kickx

Berkeley M. J. in Smith J. E.: English flora 236, (1836); Hooker's Jour. of Bot. 6, 226, (1854); Jour. Linn. Soc. 10, 384, (1896); Grevillea 4, 49, (1875). Bizzozero G. Flora veneta critt. 1, 199 (1885). Brefeld O. Untersuch. aus dem gesamt. der Myk. X, Ascomyceten 2, 260, (1891). Bresadola G. & P. A. Saccardo Malpighia 11, 294, (1897) Currey F. Trans. Linn. Soc. Lond. 22, 264, (1859). Dennis R. W. G. British Cup Fungi 177, (1960). Gwynne-Vaughan H. C. I. & B. F. Barnes Structure and Development of the Fungi 269 (1937). Hoffmann G. F. Vegetabilia cryptogamica 1, 20, (1787). Kickx J. Flore Crypt. Louvain 116, (1835); Flore crypt. Flanders 307, (1867). Miller J. H. Mycologia 20, 203, (1928); World Species of *Hypoxylon* 13, (1961).

sub *Hypoxylon coccineum* Bull.

Berlèse A. N. & G. Bresadola Ann. Soc. Alp. Trid. 14, 21, (1887-1888). Bulliard P. Hist. Champ. de Fr. 174, (1791). Hedwigia 1, 70-71, (1855). Cooke M. C. Handbook of British Fungi II, 794, (1871); Handbook of Australian Fungi 293, (1892). De Notaris G. Sferiacei Ital. 14, (1863). Ellis J. B. & B. M. Everhart Jour. Mycol. 4, 39, (1888); N. Amer. Pyren. 629, (1892). Fuckel L. Symb. Myc. 233, (1869-1870). Karsten P. A. Mycologia Fennica II, 38, (1873). Kickx J. Flore crypt. Flanders 1, 19, (1840). Lambotte E. Flore Mycol. belge 419, (1880). Lupo P. Bot. Gaz. 73, 486-495, (1922). Miller J. H. Trans. Brit. Mycol. Soc. 15, 146 (1930). Montagne J. F. C. in Gray: Hist. Chile VII, 441 (1850). Nitschke T. Pyren. Germ. 1, 28, (1867). Owens C. E. Proc. Indiana Acad. Sci 1911, 304, (1912). Petch T. Ann. roy. bot. gard. Perad. 8, 149, (1924). Quélet L. Champ. Jura et Vosges 491, (1875). Rabenhorst L. Kryptflor. Deutsch. II, 865, (1887). Saccardo P. A. Fungi Ital. 506, (1877-1886). Shear C. L. Mycologia 20, 84, (1928).

- sub *Hypoxylon dubiosum* Speg.
Spegazzini C. Anal. soc. scient. Arg. **18**, 272, (1884).
- sub *Hypoxylon majusculum* Cke.
Cooke M. C. & C. B. Plowright *Grevillea* **7**, 80, (1879).
- sub *Peripherostroma fragiformis* (Pens ex Fr.) Gray.
Gray S. F. *British Plants* **I**, 513, (1821).
- sub *Sphaeria cocconea* Hooke
Hooke W. J. *Flora Scotica* **II**, 4, (1821). Rabenhorst G. L. *Deutsch. Kryptflor* **I**, 202, (1844-1848). Sommerfelt S. C. *Supp. flor. Lapp.* 211, (1926).
- sub *Sphaeria fragiformis* Pers.
Dickson J. *Fasc. plant. crypt. britt.* **I**, 24, (1875). Fries E. M. *Observationes mycologicae* 170, (1815); *Syst. Mycol.* 332, (1823); *Elenchus fungorum* 62, (1828); *Grevillea* R. K. *Scottish crypt. Flor.* **3**, 136, (1825). Hooke W. J. *Flora Scotica* **II**, 4, (1821). Persoon C. H. *Syn. Meth. Fung.* 9, (1801).
- sub *Valsa fragiformis* Scop.
Scopoli J. A. *Flora Carniolica* 399, (1772).
For other references see Miller (1961) p. 13.

Stromata pulvinate to hemispheric with circular base, normally aggregated, $3.0-16 \times 4.0-31 \times 2.5-5.0$ mm, superficial on bark. Outer layer brick orange to orange brown, interior of ectostroma deep orange to black at sight, brittle refractive, disintegrating into orange or blood-red particles in microscopic preparations. Entostroma massive, corky, black. Perithecia evident at vertices, to completely immersed, ovate, $200-700 \times 300-1200\mu$, close crowded in palisade formation; ostioles not visible or clearly umbilicate, $130-180 \times 6-9\mu$; stipes $40-90\mu$. Spores gibbous, navicular or crescentic, dark brown, $3.5-7.5 \times 7.5-15.5\mu$, ave. $5.7 \times 12.0\mu$.

Material examined:

Perfect Stage:

A large quantity of material in the herbaria cited. Martin 626 ex Barnett & Stipes 1470; Morgantown, W. Va., U.S.A., (1961). Martin 893 ex CBS, Baarn (culture only), (1961). Martin 1610 (+ *Graphium* stage); Stonybrook, Rockland Co., N.Y. State, U.S.A., (1963). Martin 1648 (+ *Graphium* stage); Roxbury, Conn., U.S.A., (1963). Martin ex Randolph; Vermont, U.S.A., (1962). Martin 1742, 1743, 1747 ex Rogerson; on *Fagus* Wine Hill, Oneonta Township, Otsego Co., N.Y. State, U.S.A., (1963). Martin 1773 ex Carroll 135; Swarthmore, Pa., U.S.A. (1963). Martin 1816 ex Carroll 104; Jylland, Denmark, (1963).

Imperfect Stage:

sub *Institale acariforme*

Dearness in Ellis & Everhart's *Fungi Columbiani* 2036; on *Betula lutea*, London, Ont., Canada (1904), (AA). Ellis 1328; Westchester, Pa., U.S.A., (1883), (AA). Johnson 1629; Ann Arbor, Mich., U.S.A., (1894), (AA).

sub *Isaria umbrina*

Langlois in *Flora Ludoviciana* 2199; on *Quercus*, St. Martinsville La., U.S.A., (NYBG). Murrill 1201; Youghigeny River, Pa., U.S.A., (1905), (NYBG).

Cultural characters (Plate V: 7):

Colonies felty to velvet felty, with fine coarse texture; aerial mycelium uniformly dull white or more characteristically variegated, coloured orange, reddish or green. Mycelial aggregates sometimes present, soft. Margin sometimes lobed, not distinct; hyphae lying together. Conidia produced early or in age. Stain characteristically olive green, lightening to red-brown or red-orange to the exterior. Growth rate moderate, $2.4-3.3$ mm/day at 25°C .

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 1.5μ . Secondary mycelium loose, $1.8-3.1\mu$ in diameter.

Imperfect stage (Plate VII: 7; Plate X: 7, 8). See also Martin (1967), p. 232, fig. 3.

sub *Anthina flavovirens* Fr.

Fries E. M. Syst. Mycol. III, 284, 1829.

sub *Hypoxylon coccineum* Bull

Brefeld O. Untersuch. aus dem Gesamtgebiete der Myk. X. Ascomyceten 2, 260, (1891). Jaczewski A. L. Bull. Soc. Myc. de Fr. 11, 125, (1895). Schroter J. in Cohn: Kryptflor. Schlesien 462, (1908).

sub *Institale acariforme* Fr.

Fries E. M. Syst. Mycol. III, 210, (1823). Saccardo P. A. Syll. Fung. I, 353, (1882).

sub *Isaria hypoxylon* Kalchbrenner

Rabenhorst L. Hedwigia 3, 73, (1864).

sub *Isaria umbrina* Pers.

Persoon C. H. Syn. Meth. Fung. 9, 689, (1801-1808). Saccardo P. A. Atti Soc. Ven. Trent. Sci. Nat III, 152, (1873), Syll. Fung. IV, 590, (1886). Tulasne L. & C. Selecta Fungorum Carpologia II, 4, (1863).

The *Graphium*-type coremia were fairly commonly found in nature by the writer in association or connection with immature stromata, and cultures made from these were identical to those from ascospores. In contrast to the sporadic dendroid coremia of *H. cohaerens* (Papillata Group) which are otherwise similar in form, these usually form a circlet around the base of the stroma, and each member is somewhat penicillate, ochraceous to orange brown, $70-170 \times 600-1400\mu$. They have not been observed in culture.

Conidiophores indistinct on coremia; in culture comprising systems $150-270 \times 1.8\mu$, branched dichotomously to the first or second degree over the upper parts of the axes. Fertile branches lying freely, with unmodified heads, $30-96 \times 1.2-1.8\mu$. Conidia in fascicles off unmodified hyphae, acrogenous or pleura-crogenous, borne on slender sterigmata, clavate with narrow bases or pyriform, white collectively, $1.5-2.5 \times 3.7-6.8\mu$, ave. $2.0 \times 5.0\mu$.

26. *Hypoxylon howeianum* Peck.

Dennis R. W. G. British Cup fungi 177, (1960). Miller J. H. Mycologia 20, 202 and 312, (1928); Trans Brit. Mycol. Soc. 17, 125, (1932); World Species of *Hypoxylon* 15, (1961). Owens C. E. Proc. Indiana Acad Sci. 1911, 303, (1912). Peck C. 24th Report NY State Museum, 98, (1878).

sub *Hypoxylon commutatum* Nitschke

Bizzozzero G. Flora veneta. critt. 1, 199, (1885). Ellis J. B. and Everhart Jour. Mycol. 4, 40, (1888); N. Amer. Pyren. 630, (1892). Fuckel L. Symb. Myc. 233, (1869-1870). Jaczewski A. L. Bull. Soc. Myc. de Fr. 11, 127, (1895). Nitschke T. Pyr. Germ. 1, 33, (1867). Rabenhorst L. Krypt flor. Deutsch II, 863, (1887). Saccardo P. A. Fungi Ital. 567, (1877-1886). Sydow H. & F. Petrak Ann. Mycol. 20, 184, (1922). Traverso J. B. Flora Ital. Crypt. 1, 42, (1906).

sub *Hypoxylon enteromelum* (Schw.) Berk.

Berkeley M. J. Grevillea 4, 51, (1875). Ellis J. B. & B. M. Everhart Jour. Mycol. 4, 40, (1888); N. Amer. Pyren. 630, (1892).

sub *Hypoxylon multifforme* Fr. var *australe* Cke.

Cooke M. C. Grevillea 11, 129, (1883).

sub *Hypoxylon pulcherrimum* von Hohn.

Von Hohnel F. Ann. mycol. 3, 187, (1905). Lloyd C. G. Myc. Writ. 7, 1289, (1924).

sub *Sphaeria enteromela* Schw.

Schweinitz L. v. d. Trans. Amer. Phil. Soc. Philad NS 4, 190, (1832).

Stromata pulvinate to hemispheric, less commonly somewhat aplanate, $1.2-20 \times 1.8-62 \times 1.5-7.5$ mm, superficial on bark or wood. Subiculum sometimes present, orange, of densely branched close anastomosed hyphae $1.8-2.5\mu$ diameter. Outer layer orange brown to brick orange, entostroma refractive, deep orange to black at sight, disintegrating into orange particles in microscopic mounts. Entostroma massive, corky, black. Perithecia evident at vertices to completely immersed, close crowded in palisade formation, rarely simply adjacent, ovate, $200-400 \times 300-600\mu$; ostioles invisible or clearly umbilicate. Asci cylindric, $80-155 \times 4-8\mu$; stipes $36-83\mu$ long. Spores gibbous to navicular, medium to dark brown, $3.2-6.5 \times 6.0-11.5\mu$, ave. $4.1 \times 8.3\mu$.

Material examined:

A large quantity of material in the herbaria cited. Martin 1698, 1699; Mt. Toby State Forest, Mass., U.S.A., (1963). Martin 1761 ex Carroll 107, Copenhagen, Denmark, (1962). Martin 1773 ex Carroll 135; Swarthmore, Pa., U.S.A., (1960). Martin 1826 ex Kramer; Lydon, Osage Co., Kansas, U.S.A., (1963).

Cultural characters (Plate V: 4):

Colonies felty to velvet felty, with fine texture or rarely somewhat coarse, dull white with mottled green or cream discolouration. Mycelial aggregates present, soft, sometimes extensive. Margin not distinct, hyphae lying together. Conidia usually developed early, sometimes only with age. Stain characteristically intense olive green, sometimes bottle green or greenish brown. Growth rate moderate to fast, $2.3-7.3$ mm/day at 25°C .

Microscopic characters (Plate VII: 10):

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 2.5μ . Secondary mycelium loose to characteristically reticulate tentacular, $1.5-6.2\mu$ in diameter.

Conidiophores and conidia:

Conidiophores fairly short, $25-210\mu$; axes $0.9-1.8\mu$, colourless or sometimes with a green tint, with smooth or warted walls, unbranched or branched dichotomously or ternately to the first degree to indefinitely over the upper parts or apices of the main axes. Fertile branches narrow or swollen clavate, with unspecialized or slightly swollen heads, $2.5-23 \times 0.6-3.1\mu$; usually lying freely, sometimes in trident formation. Conidia acrogenous, sometimes also in fascicles off the hyphae, sessile or borne on slender sterigmata, clavate with narrow bases or ovate, white to cream *en masse*, $2.5-4.3 \times 5.0-7.5\mu$, ave. $3.5 \times 6.0\mu$.

27. *Hypoxylon daldiniforme* Martin, nov. sp. (Plate II: 19)

Stromata magna, globosa vel aplanopulvinata; ab *Hypoxylon mulleri* differtur pigmento aurea.

Stromata globose to aplanopulvinate, usually large but ranging greatly in size, $6.0-28 \times 6.0-70 \times 15-22$ mm, somewhat similar to species of *Daldinia* but always sessile on the substrate. Surface of stroma smooth, bright yellow orange; ectostroma brittle refractive, saffron yellow at sight and separating into yellow particles in microscopic mounts. Entostroma massive, corky, dull brown to jet black, with 1-2 narrow concentric zones. Perithecia immersed, adjacent, globose to ovate, $200-300 \times 600-800\mu$; ostioles punctate umbilicate, sometimes indistinct. Asci not seen. Spores oval, navicular to crescentic, ends narrow rounded, pale brown, subhyaline, $3.0-4.5 \times 7.5-9.0\mu$, ave. $3.9 \times 8.7\mu$.

South African hosts: Wood, unidentifiable.

Material examined:

Martin 235, 546; Hogsback, nr. Alice, Eastern Cape, South Africa, (1958, 1959).

Cultural characters (Plate IV: 18):

Colonies with closely appressed mycelium, canescent subhyaline to grey opaque. Margin indistinct, compact, entire or slightly lobed. Conidia inconspicuous, scattered uniformly, pink, appearing after 1 week. Stain olive green behind margin, to dull red at the centre. Growth on other media similar but without conidia; stain fiery red orange on Czapek. Growth very slow, 0.9 mm/day at 25°C.

Microscopic characters (Fig. II: 15):

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 2.2μ . Secondary mycelium ropy, light brown, $1.8-3.7\mu$ in diameter, forming strands of several hyphae thick.

Conidiophores and conidia (Fig. II: 6):

Conidiophores scarcely distinct from the vegetative mycelium, $100-330\mu \times 1.8\mu$, indefinitely and dichotomously branched throughout their length. The fertile branches are terete, lying freely, usually with small globose apices, $10-25 \times 1.0-2.0\mu$. Conidia acrogenous, in clusters of 3-8, sessile, clavate with narrow bases, pink to cineraceous *en masse*, $1.7-2.6 \times 2.9-4.3\mu$, ave. $2.4 \times 3.6\mu$.

This species appears to be close to *H. mulleri* Mill., differing in the brighter colour of the stroma.

28. *Hypoxylon sclerophaeum* Berk. & Curt. (Plate I: 13)

Berkeley M. J. Jour. Linn. Soc. **10**, 383, (1869). Berkeley M. J. & M. C. Curtis Jour. Acad. Nat. Sci. Philad. **II**, 285, (1853). Cesati V. Atti R. acad. Scienze fisich e matem. **8**, 19, (1879). Cooke M. C. Handbook of Australian Fungi 292, (1892). Miller J. H. Monog. Linn. Puerto Rico **B 2**, 203, (1934). World Species of *Hypoxylon* 40, (1961).

- sub *Daldinia asphalatum* (Link & Fr.) Sacc.
Hennings P. Hedwigia 47, 259, (1908). Lloyd C. G. Myc. Writ 7, 1231, (1923). Saccardo P. A. Syll. Fung. 1, 394, (1882).
- sub *Daldinia exsurgens* Theissen
Theissen F. Ann. Mycol. 7, 4, (1909).
- sub *Daldinia placentiformis* Theissen
Theissen F. Ann. Mycol. 7, 4, (1909).
- sub *Hypodiscus placentiformis* (B. & C.) Rick.
Rick J. Broteria ser. bot. V 25, 34, (1931).
- sub *Hypoxylon asphalatum* (Link & Fr.) Mont.
Montagne J. F. C. Ann. Sci. Nat. 4, ser. 3, 118, (1855).
- sub *Hypoxylon collatum* Cke.
Cooke M. C. Grevillea 11, 128, (1883).
- sub *Hypoxylon placentiforme* Berk. & Curt.
Berkeley M. J. Jour. Linn. soc. 10, 383, (1869). Von Hohnel F. Denk. Akad. Wiss. Wien. mathem. nat. Klasse 83, 26, (1927).
- sub *Hypoxylon wrightii* Berk.
Berkeley M. J. Jour. Linn. Soc. 10, 383, (1869). Berkeley M. J. and M. C. Cooke. Jour. Linn. Soc. 15, 396, (1877).
- sub *Nummularia cookeana* Rehm
Rehm H. Leaf. Philipp. Bot. 6, 2273, (1914).
- sub *Nummularia placentiformis* (Berk. & Curt.) Sacc.
Hennings P. Hedwigia 47, 258, (1908). Hennings P. Hedwigia 36, 228, (1897). Saccardo P. A. Syll. Fung. 1, 399, (1882).
- sub *Nummularia suborbicularis* (Welw. & Curr.) Sacc. var. *cookeana* Sacc. Saccardo P. A. Syll. Fung. 1, 399, (1882).
- sub *Nummularia wrightii* (B. & C.) Sacc. Saccardo P. A. Syll. Fung. 1, 398, (1882).
- sub *Hypoxylon nicaraguense* E. & E. Ellis J. B. & B. M. Everhart
Bull. Lab. Nat. Hist. Linn. Iowa 2, 407, (1893).
- sub *Hypoxylon parkii* Lloyd. Lloyd C. G. Myc. Writ. 7, 1348, (1924).
- sub *Hypoxylon tahitiensis* Lloyd. Lloyd C. G. Myc. Writ. 7, 1314, (1924).

Stromata pulvinate to aplanate, $3.2-41 \times 12-63 \times 1.8-11$ mms, initial stage tawny yellow but at maturity with reddish brown, red-purple or dull brown flat or convex surface, usually rather large and thick. Ectostroma brittle refractive, sometimes extremely hard, black at sight but disintegrating into vinaceous particles in microscopic mounts. Entostroma massive, corky to somewhat carbonaceous, dull brown to black. Perithecia evident at the vertices to completely immersed, in palisade formation, long ovate, $400-1000 \times 700-1600\mu$; ostioles very small papillate, not visible, or umbilicate. Asci cylindric, $115-140 \times 8-10\mu$; stipes $40-50\mu$ long. Spores gibbous, navicular or crescentic, dark brown to black, rarely pale brown, $5.0-8.0 \times 10.5-21.5\mu$, ave. $6.5 \times 12.6\mu$.

This species is doubtfully distinct from *H. papillatum* E. & E. where the ectostroma and surface is yellow or ochraceous rather than reddish.

Material examined:

- Martin 1073 ex Schroeder; Guatemala, (1962). Martin 1086, 1087, 1088; Columbia, Mo., U.S.A. (1962). Martin 1507; San Blás, Nayarit, Mexico, (1962). Martin 1774 ex Carroll 137; Rachaburi, Thailand (1963). Martin 1822 ex Kramer in Herb Kansas SC 21; Leavenworth Co., Kansas, U.S.A., (1958), (with *Graphium coremial* stage). Martin 1827 ex Kramer; Lydon, Kansas, U.S.A., (1963).
- sub *Hypoxylon collabens*
Rick; Brazil (1926), (AA).
- sub *Hypoxylon placentiforme*
Rick in Fungi Austro americani 335; San Leopoldo, Brazil, (1907), (NYBG).

Cultural characters:

Colonies at first canescent, later becoming felty to cottony, with coarse texture, dull white. Mycelial aggregates slight to moderate in quantity. Margin not distinct, hyphae widely dispersed or lying together. Conidia are developed by 7 days but remain inconspicuous. Stain amber or olive green. Growth rate fast, 4.5–6.4 mm/day at 25°C.

Microscopic characters:

Primary mycelium undiagnostic; marginal hyphae with maximum diameter of 3.1μ . Secondary mycelium reticulate-tentacular, as in *H. subchlorinum* and *H. howeianum*, 1.8 – 5.0μ in diameter.

Conidiophores and conidia (Plate X: 1-3):

Coremia were observed in association with collected stromata but as they did not develop in culture they cannot be regarded as belonging to this species with certainty. These coremia occur sporadically as in *H. oodes*, are clavate, dull brown, fertile over the apices, 0.1 – 0.2 – 0.3 mm. The coremial conidiophores are smooth walled, tinted dull brown, fairly short, 39 – $75 \times 3.0\mu$, unbranched or branched dichotomously to the first degree. The fertile branches are borne freely, 12 – 25×2.7 – 3.1μ , and bear apical conidia off slender sterigmata. The conidia are narrow pyriform, red brown, 0.6 – 1.2×4.3 – 5.5μ , ave. $0.9 \times 4.9\mu$.

The conidiophores developed in culture are longer and more developed, smooth or warted, colourless or tinted dull brown, 52 – 210×1.2 – 3.1μ . They are unbranched or branched up to the second degree over the length of the main axes or the upper parts only. Two to four branches arise from each division. The fertile branches are borne in trident formation and are narrow or swollen clavate with the heads unspecialized to distinctly globose, 7.5 – 37×1.8 – 3.1μ . The conidia are acrogenous, sessile or on stout sterigmata, broad or narrow clavate to oval, yellow en masse, 2.5 – 4.3×4.3 – 8.1μ , ave. $3.3 \times 6.1\mu$.

DISCUSSION AND CONCLUSION

The description of twenty-seven species shows how difficult the classification of this section of *Hypoxylon* is. Although the use of a large number of characters undoubtedly serves to delimit the species better, the character-states do not correlate in such a way as to give broad differences that can be simply or explicitly defined. The fairly independent linkage among the characters is summarized in the table, which should be compared with that drawn up for the section *Entoleuca* (Martin 1968, p. 197). Perhaps further work on physiology and nutrition may resolve problems of specific limits that a practically exclusive morphological study has created.

CHARACTER					SPECIES SERIES		
Stromata restricted; ostioles umbilicate	Ectostroma with bright coloured particles	Stain on colony reverse red, violet brown or absent	<i>Graphium</i> -type coremia absent from stromata	<i>Sporothrix- Calcarisporium</i> Types I-II in culture	Stromata surface yellow/orange	<i>H. jecorinum</i>	
				Type III	Stroma surface green	<i>H. viridicolor</i>	
					Conidia rapid, profuse	<i>H. occidentale</i>	
						<i>H. albostigmatosum</i>	
						<i>H. bicolor</i>	
				Stroma surface red/brown/purple	<i>H. croceopileum</i>		
				<i>Acrostaphylus</i>	2nd mycelium reticulate tentacular	<i>H. subchlorinum</i> II	
					<i>H. novemexicanum</i>		
					<i>H. bicolor</i>		
					<i>H. hypomiltum</i>		
	2nd mycelium close anastomosed	<i>H. haematostroma</i>					
	<i>H. rubrostromaticum</i>						
	Ectostroma with dull coloured particles			<i>Sporothrix- Calcarisporium</i> Types IV-V	stroma surface red/brown/purple	Conidia elongate	<i>H. dieckmanni</i>
				<i>H. fuscum</i>			
				<i>H. fuscum</i> <i>H. vogesiacum</i> <i>H. rubiginosum</i>	III		
				<i>H. plumbinum</i>			
<i>H. ferrugineum</i>							
<i>H. daldiniiforme</i> <i>H. fragiforme</i> <i>H. howeianum</i>							
Stromata massive; ostioles umbilicate	Ectostroma bright	Stain green		<i>Sporothrix- Calcarisporium</i> Types I-II	orange	2nd mycelium reticulate	<i>H. sclerophaeum</i>
				<i>Acrostaphylus</i>	purple or various	tentacular	<i>H. croceum</i>
	Ectostroma dull	Stain red to brown or absent	± <i>Graphium</i> type associated with stromata coremia	<i>Sporothrix- Calcarisporium</i> Type V	brown	Conidia rapid, profuse	<i>H. murcidum</i>
				Type I-II	purple or various	elongate	<i>H. riograndense</i> <i>H. oodes</i>
Ectostroma bright			Type III		orange		<i>H. aureostroma</i>
Stromata commonly uniperitheciolate or with perithecia developing separately in stromal matrix; ostioles ± papillate							

Of particular interest is the association of distinct types of conidiophore with various species. Five types were defined by Martin previously (1967, p. 231) and these often vary somewhat within the same species; however the range of variation is usually limited so as to make the entities comprising types I—II, IV—V and type III almost mutually exclusive.

It is type I—II that agrees closest with the type species of *Sporothrix*, *S. schenckii* (Plate VII: 3) which leads to the idea that the latter may be a degenerate form of one of the species of *Hypoxylon*. However a perfect stage for *S. schenckii* is unknown, even though it inhabits wood; conversely there is no imperfect stage of *Hypoxylon* known to be dimorphic, and the writer has not succeeded in producing such a form even with ultraviolet irradiation. Moreover the *Sporothrix* (*Sporotrichum*) imperfect stage is known for other genera in the Ascomycetes (Tubaki, 1958, p. 199, Barron *et al.*, 1961).

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ERRATA

- MARTIN, P. 1967 Studies in the Xylariaceae I. J. S. Afr. Bot. **33**, 205—240.
p. 225: penultimate line, for *H. denstum* read *H. deustum*.
p. 228: in legend, for *Sporotrichum* read *Sporothrix*. for *Hypoxylon hypomiltum* read *Hypoxylon bicolor*. for *Hypoxylon murcidum* read *Hypoxylon dieckmanni*.
MARTIN, P. 1967. Studies in the Xylariaceae II. J. S. Afr. Bot. **33**, 315—328.
p. 327: line 47, for *Gothrinum* read *bothrinum*. line 48, for *Gothrina* read *bothrina*.